THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 24. Thursday, October 27th, 1921. No. 271.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

The Foundry Trade Journal,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI, LONDON, W.C.2.

Contents.

	PAGE
Notes and Comments	331
Trade Talk	332
Some Principles Underlying Foundry Practice	333
A New Feature of the "General" Moulding Machine	336
Moulding and Belt Pulley in Halves	337
Foundry Reorganisation—Part V.	338
The New "Ford" Foundry	339
Concrete Results from Research	342
A Cupola Tapping Device	343
A Flask of Novel Design	343
The New Iron Foundry of Messrs. Mavor & Coulson	344
Institution of British Foundrymen	345
Gazette	347
Deaths	347
Company News	347
Personal	347
The Eleventh Report of the Light Alloys Research Committee	348
Iron and Steel Markets	351

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

Institution of British Foundrymen.

PRESIDENT, 1921-1922: Mr. Oliver Stubbs, M.I.Mech.E., Openshaw, Manchester.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, Bessemer House, Adelphi, Strand, London, W.C.2.
Manchester: J. Hogg, 365, Manchester Road, Burnley, Lancs.
Birmingham: F. B. Holberry, 22, Salisbury Road, West Bromwich.
Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.
Scottish: W. H. Bound, 16, Grantley Gardens, Shawlands, Glasgow.
London: V. C. Faulkner, 21, Stanley Gardens, W.11.
Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
Coventry: F. H. N. Lane, Queensbury, 2, Dover Street.

Welsh Engineers' and Founders' Association.
Secretary: E. J. Griffiths, 20, Fisher Street, Cardiff.

NOTES AND COMMENTS.

"Sorby" Lecture.

An appeal is being made by the Sheffield Society of Engineers and Metallurgists, the Sheffield Association of Metallurgists and Metallurgical Chemists, the local branches of the Institute of Metals, the Institution of British Foundrymen, and the Junior Institution of Engineers, for funds to enable them to continue on a more permanent basis—annually, if possible—the "Sorby" lecture, inaugurated by the Sheffield Society of Engineers and Metallurgists in 1914, and discontinued owing to the war.

Dr. Henry Clifton Sorby conducted researches and made many discoveries in several branches of pure science, which made for him a world-wide reputation. Probably the most outstanding features of his work are the facts that he was undoubtedly the pioneer both of the application of the microscope to the study of rocks in 1863, and, later, to the examination of metals, and, although he was always engaged in the pursuit of pure science, he showed great pleasure when he heard of the successful application of his work to industry.

The metallurgical industry in general, and the staple trades of Sheffield in particular, have thus had a valuable means placed at their disposal of investigating metals, and it is felt that it is desirable to perpetuate the name of Dr. Sorby by means of this lecture.

In order to achieve this object, it is necessary that funds should be raised, and if the lecture is to be worthy the name of Sorby, £1,000 will be required. It is felt that the members of all the associated Societies will respond in such a way as to ensure the success of the scheme.

Contributions to the fund are invited, and should be sent to Mr. E. J. Thackeray, Department of Applied Science, the University, Sheffield.

The Slow-Pouring of Castings.

This subject was recently discussed by the Lancashire Branch of the Institution of British Foundrymen, and whilst some excellent practical points were developed, the basic principles underlying Mons. Ronceray's method were left untouched. The meeting failed to differentiate between the Brunelli process and the French one. The former consists in the breaking up of the stream into many jets, or, in other words, a filtration process, whilst the latter dispenses with any head of metal by the use of a gate of narrow section, usually introduced at the base of the casting, sometimes through the core, and often accomplished with an unvented mould. Basically, both of these methods diminish the chances of slag inclusions, but much importance should be attached to the greatly increased area of liquid metal which would be exposed to the action of the sand forming the walls of the gate. It has been asserted that grey cast iron contains gases to the extent of 340 times its volume. By the exposure of a large surface, more grains of iron are in contact with the sand and evolve at this time, instead of later, much of the gas, which might be the cause of depressions and coarse grain under feeding heads.

M. Ronceray's formula does not yet appear to have had practical application, possibly because it is expressed in metric figures. Using the British system of weights and measures, it admits of the rough change into $S=0.015\times\sqrt{P}$, where S is the cross sectional area of the gate in square metres and P the weight in lbs. of the casting above the gate. Thus, if a casting weighs 36 lbs., the section of the gate should be 0.09 of a sq. in. This would allow of a ⅓-in. square gate. We stress this point, as obviously it is advisable that foundrymen checking his results should start off from the basis M. Ronceray has indicated, introducing the variants as experience accrues.

A point worthy of consideration was brought to the notice of the meeting by the Branch President, Mr. Meadowcroft. He indicated that in the case of castings presenting a flat surface of large superficial area, the cope was likely to perish before the metal reaches it. Whilst M. Ronceray does not recommend his method for this type of casting, it might be overcome in a few cases by turning the mould through a right angle, and making the flat surface a vertical one instead of horizontal.

A question which must not be overlooked when carrying out experiments of this nature is the provision of a self-ventilating sand, as it is here that much of the success of the process lies, and unfortunately it is only by trial and error that this is to be obtained at the moment. There is room in every foundry for a machine to test the permeability of sand. We feel sure that a machine, based on the principle of applying a standard pneumatic pressure through a body of sand of standard thickness and measuring the time necessary for the pressure to become normal, would provide much interesting data. When some standard results became available, modifications could be introduced for the testing at high temperatures in a similar manner to those used for ascertaining the mechanical properties of alloys.

Trade Talk.

NOBEL'S INDUSTRIES, LIMITED, intend to establish a factory at Heath, near Chesterfield.

MESSRS. H. SHORE & COMPANY, iron and steel merchants, have removed to 106, Cleethorpes Road, Grimsby.

MESSRS. J. M. TERRY & COMPANY have established a branch at 5, 6 and 7, Great Hampton Street, Birmingham.

THE directors of the Still Engine Company, Limited, have offered £25,000 8 per cent. debentures and 25,000 A shares of 1s. each to shareholders.

WILLIAMS, FOSTER & COMPANY, and Pascoe Grenfell & Sons, Limited, are removing their London warehouse to 48 to 50, Bermondsey Street, London, S.E.1, on November 1.

THE SHEEPBRIDGE COAL AND IRON COMPANY, LIMITED, have been awarded the contract for a considerable portion of the turbine castings for the first new battleship to be laid down.

S. F. BINGHAM & COMPANY, Athenæum Chambers, Temple Row, Birmingham, have been appointed agents for Andrew Handyside & Company, Limited, Britannia Iron Works, Derby.

MR. W. E. POPPLETON lectured on the subject of "File Cutting and File Teeth," at the Mappin Hall, Sheffield, on October 13, in connection with the Sheffield File Trades Society.

THE IRON AND STEEL TRADES CONFEDERATION announce that arrangements are practically complete for eye cataract to be scheduled as a disease under the Workmen's Compensation Act.

AFTER being unemployed for nearly twelve months, over 200 iron-ore miners have recommenced work at the pits of the Barrow Hematite Steel Company and the Newton Mining Company, in the Furness area.

BEFORE THE MEMBERS of the North-East Coast Institution of Engineers and Shipbuilders, on Wednesday, a lecture was delivered by Major-General Sir Sefton Brancker on "Progress of Aviation Since the End of the War."

THE AVERAGE PRICE of manufactured iron in the West of Scotland for the two months of July and August was 340s. 1½d. per ton, a decrease of 52s. 3d. on the previous audit, and of 273s. 5d. on the corresponding two months of a year ago.

AT THE Continental Conference of the Shipping Board, representatives of the shipping companies announced a reduction in freight rates to Continental Europe varying from fifteen to twenty per cent. per ton on metals, and three to five per cent. on oils, etc.

THE ascertainment of the selling price of tinplate bars for July, August and September at £8 5s. 3½d. was made known last week. This affects the basis of wages in the tinplate trade and means a reduction in the bonus by 37½ per cent. (viz., to 7½ per cent.).

THE COLONIAL OFFICE state that the Government of New South Wales has approved the placing with a Lancashire firm of an order for boilers required to equip the electric service of Newcastle, New South Wales. The expenditure involved will be about £50,000.

THE SECRETARY of the Royal Metal Trades' Pension Society requests us to again draw attention to the fifth annual whist drive on Thursday, November 3, at the Portman Rooms, Baker Street, London, W. Mr. T. S. G. Ramsey, of S. Ramsey & Company, will act as chairman.

THE ENGLISH ELECTRIC COMPANY OF AUSTRALIA proposes to manufacture aluminium at its new works at Spotswood, Melbourne. Alunite exists in Victoria, and in exceeding rich deposits at Bullahdeelah in New South Wales. The exports of alunite from 1890 to 1918 amounted to 57,000,000 tons.

SINCE THE beginning of 1921 (states the "Labour Gazette") changes in rates of wages reported to the Department have resulted in a net reduction of over £3,800,000 in the weekly wages of nearly 6,600,000 workpeople and a net increase of over £25,000 in the wages of about 150,000 workpeople.

THE MASTER CUTLER OF HALLAMSHIRE has decided not to hold the Cutlers' Feast this year. The opinion, however, is widely held that the feast might have been reduced to a plain dinner of three courses, and participation in a dinner of a simple character would have been a more satisfactory solution.

THE BOARD OF TRADE announce that they have instructed their agents in Australia to ship a supply of Broken Hill zinc concentrates to this country. They will be prepared to maintain supplies to meet the immediate requirements of smelters in the United Kingdom, if desired, in order to enable works to be restarted.

THE DEPARTMENT OF OVERSEAS TRADE announces that the Norwegian Storting has granted a concession to "A/S Akersbanerne" for the construction of an electric railway from the centre of Christiania to Ostensjo, a distance of about eight kilometres. This line will probably be commenced simultaneously with the construction of the Majorsteun-Sognsvandet railway, a concession for which was also granted recently.

SPEAKING AT the launch of the "British Enterprise," an oil tank steamer from Messrs. Beardmore's Yard, Dalmuir, Lord Invernairn touched upon prices of steel, and said that unless steel came down to something like pre-war figures, there would be no alternative but to close down the steelworks—which would mean more unemployment.

WRITING IN THE Works Magazine of Swan, Hunter & Wigham Richardson, Limited, of Wallsend, and Barclay, Curle & Company, Limited, of Glasgow, Sir G. B. Hunter discloses the fact that the market for shipbuilding is so bad that "since the beginning of the year no new order to build a ship has been received for Wallsend."

MR. W. T. LAYTON, Director of the National Federation of Iron and Steel Manufacturers, states that while before the war we imported 18,000 tons of pig-iron per month, and exported 100,000 tons per month, the present position is that last September we imported 121,000 tons and exported only 7,000 tons. This is attributed to the high price of coal in England.

ACCORDING TO H.M. TRADE COMMISSIONER at Toronto, a Canadian firm are in the market for the purchase of four cast-steel sheaves, each 10 ft. in dia., complete with shafts, sole plates, bearing and pedestals, two of the sheaves to be grooved for ropes of 1¼ in. dia. and two for ropes of 1½ in. dia. Particulars can be obtained at the Department of Overseas Trade.

THE PERCENTAGE unemployed among members of trade unions from which returns are received was 14.8 at the end of September, compared with 16.3 at the end of August. The percentage unemployed among workpeople insured under the Unemployment Insurance Act fell from 13.15 at August 26, to 12.2 at September 30. The latter figures do not include persons who removed their books after exhaustion of benefit.

THE OPENING MEETING of the new session of the West of Scotland Iron and Steel Institute was held on October 21 in the Royal Technical College, Glasgow. In his inaugural address, the President (Mr. Andrew Gray, of the Lanarkshire Steel Company) reviewed the adverse conditions prevailing in the iron and steel industries and their causes. Subsequently Mr. J. S. Atkinson, of London, read a paper on "Steel Works Furnaces and Gas Producers."

THE RAILWAY CLEARING HOUSE announces that from November 1 a temporary reduction will be made in the rates for conveyance between places in Great Britain of iron ore, ironstone and limestone for blast furnaces and steelworks. It is understood that no general reduction in railway rates has at present been decided upon, but conferences are taking place between the Railway Clearing House and important trading associations. This decision was briefly referred to in our last issue.

THE SLIDING SCALE ASCERTAINMENT of the selling price of West Coast hematite pig-iron shows that for the three months ended September last the average price has been £7 16s. 7d. per ton, against £10 1s. for the previous three months. Blastfurnacemen's wages in Cumberland and North Lancashire are accordingly reduced for the three months commencing on the second full pay in October to 108½ per cent., a reduction of 33½ per cent. compared with the previous ascertainment. The scale percentage on bonus earnings in the Workington area is now 145¾ per cent., and in the Furness area 140¾ per cent.

THE THEORY that Sheffield water has special virtue for the hardening of steel was contradicted recently by Professor C. H. Desch, Dean of the Faculty of Metallurgy at the University of Sheffield. In the course of a lecture on "The Origin and Development of the Sheffield Steel Industry," he said it was stated that Sheffield water had had a great influence on the development of the industry because it had a special virtue for the hardening of steel. There was nothing in it; any pure water will do the same. The success of hardening was due to the skill of the men, and not to the quality of the water.

REPRESENTATIVES of the National Light Castings Ironfounders' Federation and of the Joint Committee of Light Metal Trades Unions, the Central Ironmoulders' Association, the National Union of Foundry Workers, the United Patternmakers' Association and the General Iron Fitters' Association have arrived at an agreement relative to the withdrawal of the Ministry of Munitions' bonuses of 12½ per cent. and 7½ per cent., affecting timeworkers and pieceworkers respectively, viz.: (1) A reduction of 4 1-6 per cent. from the wages of timeworkers and of 2½ per cent. from the wages of pieceworkers, to take effect in respect of work done on and after Monday, October 31, 1921. (2) A further reduction of 4 1-6 per cent. from the wages of timeworkers and of 2½ per cent. from the wages of piceworkers, to take effect in respect of work done on and after Monday, December 5, 1921. (3) A further reduction of 4 1-6 per cent. from the wages of timeworkers and of 2½ per cent. from the wages of pieceworkers, to take effect in respect of work done on and after Monday, January 2, 1922. It has also been agreed between the parties that no application for any further reduction in wages would be made by the Federation prior to May 1, 1922.

Some Principles Underlying Foundry Practice.*

By H. Field.

The Sphere of the Scientific Worker.

The word "academic" is not rightly applied to the scientific worker who is directly in touch with industry, but he rather prefers the much plainer name "technical." The former word has its use, and is strictly applicable to the pure science or laboratory worker rather than to the "works" man. There is a tendency on the practical man's part to call all things beyond the scope of his knowledge and intelligence by the name "academic," with which he associates "unnecessary," because unknown. To some, my own outlook on foundry work may be so classified, but I plead that all of us may show tolerance and even respect for the unknown. The true technical man stands in a midway position between the practical and real academic worker, inasmuch as it is his place to grasp the significance of work done by this latter and apply it to the tasks of the former.

The practical man is to be envied, and all tribute paid him for his skill and craftsmanship, which I entirely lack, and if to-day he will not see my point of view, the time will come when we shall work fully together. The motto of our Institution, "Science hand in hand with labour," is the only one which the foundry can adopt with any hope of complete success.

Scientific Research.

It is not proposed to discuss the general proposition that the foundry is far behind other branches of the engineering trades in the matters of standard practice, scientific methods of working, and production of uniform qualities of goods over long periods. This point has been well brought out in the propaganda work of the Cast Iron Research Association, and the formation of this body is an admission that foundry workers can make no further progress until science and research have come more fully to their aid. That it should have recourse to such an outside body is only natural, and is an economic use of existing resources, for the practical, technical, and research worker has each his work to do, and no man can work along all these lines at one time.

In surveying the whole field of foundry work there is one point which should appeal more strongly than any other as showing the need for further work, that is the lack of standard practice. It is to be hoped that the logic of the next statement will be accepted—that there is and can be only one best way of doing a thing—whatever the thing may be.

The ideal of the scientific and technical man is a very high one: to make every process subject to law, and in everything to be exact. One of the most eminent foundrymen of the last generation, W. J. Keep, said "there are too many unknown factors to allow of the metallurgy of cast iron being made an exact science," but although the number of unknown factors is large, it is inadvisable to subscribe to the conclusion drawn by Keep. The aim of science and research must be to make the metallurgy of cast iron an exact science, and from the varying ideas and methods to which every foundry adheres to raise up for the use of every foundryman a standard practice, of which it may be said that every operation is done in the one best way. Have not many of us lost sight of the fact that there can logically be only one best way—for everything?

Leaving foundry practice for a moment and referring to the geometrical systems which were evolved so long ago by Euclid, and only built up after certain axioms were allowed to be taken as granted, it must be conceded that in foundry practice we take as an axiom "that there is only one best way," and this only can be the basis of standard practice, which must be a collection of the best ways of doing every single operation which the production of perfect casting includes. For the most part this "best way" is not at present followed, and in most cases it has not yet been discovered. The very diversity of method followed by those of us who are endeavouring to reach the same goal must of itself prove the contention, for all our ways cannot be the best, and it must follow that nearly all of us are following a way other than the best, and are therefore working along lines which are wasting effort, energy, time, material, and money. Until it be discovered and agreed as to the one best way standard practice cannot be put forward. Naturally, as foundry practice includes so many varying classes of work and of so many sizes it could never be possible to adopt one uniform practice for the whole of the industry, but if the object in view be the manufacture of any one type of casting—for instance, a chilled roll or a motor cylinder—then it can be maintained that for each of these types there is one analysis of iron, one mixture of pig-irons, which is more suited to that particular casting than any other can be. Take it that this was agreed on, and imagine the different products which different founders would obtain when they melted the agreed standard mixture, showing that melting practice needs standardising with each phase of work. It is consequent on such considerations as these that it is urged in the first case what may seem an idealistic realisation that there is only one best way. Inasmuch as many harbour in their minds that they are already following this way, it will not be agreed to, for standard practice implies co-operation. No adoption of agreed systems could remove the uncertainty of the human element, but it is just because of this that it can be put forward, for it is not at all in harmony with the ideas expressed to convert this human element into a machine, and the performance of our daily tasks would still involve as much or more thought and intelligence as to-day.

Let it be clearly understood that no claim is now made that the technical man is necessarily any nearer the best way than the practical man, but by reason of the method of his training he is much more likely to admit, or rather to insist on, its existence, and where the practical man will often rest satisfied with that which is "good enough because it serves the purpose," the technical man will rarely conform to any such proposition.

Beyond the truth that every problem has its solution and every effect its cause, lies the further fact that every system or process has its appropriate laws, definite and inflexible, by which it is governed. The scope of science in industry is to discover, firstly, the laws which govern every process, and, secondly, to devise means whereby these laws, governing the production of perfect work, may be kept unbroken. It is beyond question, when logically considered, that as often as any process is carried out under exactly identical conditions, just so often must identical results be obtained, and yet the founder is constantly puzzled by varying results from apparently unvarying conditions. The argument that nothing has been altered is quite untenable, and the alternative must be adopted and ignorance admitted of the governing laws in their entirety. In other words, in few cases has there been discovered all conditions which influence the result, let alone mastered the art of keeping those conditions constant. Hence the varying results in foundry work, and the considerable degree of uncertainty which faces the ironfounder when he attempts any particular casting—a degree of uncertainty which is far greater than when the engineer essays to make an engine. The measure of this uncertainty is the measure of our ignorance, and the foundryman probably meets with more puzzling phenomena than any other craftsman, revealing the necessity for the extension of his knowledge through research. To admit the existence of such definite laws as have been referred to is to recognise that at some future time foundry practice may be as much an exact science as is the multiplication table.

Variables in Cast Iron.

Taking the case of cast iron, which occupies the premier place amongst the metals used in the foundry, the final condition in which the metal is found in the casting is influenced by a large number of factors. To enumerate these under main headings we have:—Initial conditions of manufac-

* The Presidential Address delivered before the Birmingham Branch of the Institution of British Foundrymen on Oct. 8, 1921.

ture in the blast furnace; composition; cupola conditions, including quality of fuel; casting conditions, including length of time in ladle and temperature of casting. The influence of blast-furnace conditions is important to the foundryman, but is usually outside his information, whilst the heading "composition" may be sub-divided into at least five items. In seeking to diagnose a fault, information is desirable on all these points if possible, and the result of insufficient knowledge of any of them may be the forming of a wrong and misleading verdict. The effect of variation in any one of these many influences is fairly well understood, but it is possible for several of them to deviate from the standard in the making of any one casting, and then it becomes exceedingly difficult to get to the root cause of troubles. Many workers, both practical and technical, have laid certain troubles at the feet of certain influences without being sufficiently sure that variation has not taken place in any other factor; results of work of this kind have frequently been published and have misled other workers and helped to make that confusion and uncertainty which surrounds the founder. Slow progress but certain is the only safe method, and the assurance that there is some real definite knowledge gives much confidence.

Basis for Experiments.

Probably the chief reason why exhaustive experiments, leading to definite knowledge, have not been more largely carried out on a practical scale is the very large expense involved. Experience has shown that of the very large number of experiments made on a small scale, only a few when applied to commercial practice are of any use. More particularly does this refer to crucible and cupola melting. The cupola has such immense influence on the metal passing through it that information as to the properties of pig-iron, either individual brands or mixtures, when obtained from small pot-melted heats, is no guide to the results to be obtained from cupola practice. If any are not in agreement with this it is only necessary to refer to crucible malleable versus cupola malleable for an illustration, but it can be supported by personal experience with pot and cupola and by having endeavoured to put into practice on the cupola the results obtained by other workers with the crucible. The comparison between crucible and air furnace is, of course, more valuable, and since air furnace practice is gradually extending, such experimental work as has been referred to may yet be worth while. For the present, however, the cupola holds sway, and it is to be hoped that the Research Association will not endeavour to solve the foundry troubles put up to them with the aid of a crucible or to set on foot new work along these lines, for it is not wanted, but rather investigations on practical lines. This is another factor largely contributing to the uncertainty of foundry work, but it has no doubt arisen in an endeavour to avoid expense.

Fracture and Analysis.

It having been shown that the final character of the iron is dependent on the relative strength of a number of influences, of which chemical analysis is only one, it is obviously illogical that knowledge and control of analysis alone can remedy all ills and avoid all defects. But on the other hand it has been shown that chemical analysis is one of the factors influencing final condition, and it is therefore equally illogical to argue that without analysis effective control can be maintained. No sooner, however, is the question of analysis raised than it is followed by its relationship to fracture and the degree to which each is to be admitted as a governing factor in the purchase and utilisation of pig-iron. It would appear, at any rate, that the makers of pig-iron are not yet prepared to concede that analysis is one of the determining factors in making good castings. Nowhere are we farther from standardisation—in the ordinary run of practice no two batches of iron appear to be exactly similar, no mixture can be exactly repeated over any length of time, and any attempt to adopt a standard mixture to give a standard product soon breaks down through lack of uniformity in the constituent irons. The same mixture may be used where brand or fracture is the guide, or a different mixture may be used where a standard analysis is worked to, but the resultant iron is found to vary considerably. As a first essential in the work of the Research Association and in the building up of standard practice, it should become incumbent on every blast furnace to produce and put on the market standard irons within standard limits of analysis. If the foundry trade as a whole would insist, then this object might be easily accomplished. A similar state of affairs would not be tolerated by the steel or non-ferrous industries, and as a result these metals can be bought to any desired analysis. In the case of pig-iron the blast-furnace people are found offering tables of analyses, coupled with such declaimers as:—(1) We sell this iron to analysis, but do not bind ourselves; (2) we do not sell to analysis, these figures are only approximate; (3) we do not sell to analysis, these figures are for your guidance.

These are a few actual quotations and could be multiplied very largely. Compare this with a prospectus issued by an American agent, with guarantees, and we see the difference between the founders' position in the two countries. Approximate figures are little less than useless, since there is available too much experience of being guided by them, and firm guarantees are needed. To-day in the foundry industry there is no option but to accept what the furnaces send, and those who have objected know how difficult it is; indeed, little or no redress is obtainable even in cases, by no means infrequent, where the material sent is absolutely unuseable by the founder, let alone just outside specification. If fracture be the guide it is difficult to find two men who will prescribe the exact limits of any grade, or classify similarly any dozen or so different fractures, so that without having definite standards of fractures no redress could be expected when the buyer is dissatisfied with his purchase; but analysis does provide definite standards to which it can easily be seen if any sample conforms. Sale by analysis will not leave the blast furnaces with a good deal of unsaleable iron, for, generally speaking, all iron is good iron when properly used; if it were indeed found that certain iron were unsaleable because there was no good use for it, then who amongst founders will grumble? It can readily be understood that even amongst founders this view of the case is not universally accepted, because to some who have failed to keep pace with modern developments an analysis conveys nothing whatever. This in spite of the facilities which have long been available at little cost in the shape of trade literature, evening classes, and the work of this Institution, which together have familiarised members and others with the terms and meaning of a chemical analysis. The method of grading by fracture has been on trial for a long time, and having failed to give the required degree of certainty to ironfounders, it is doomed to give place to the method of analysis. It may be that this, too, will prove a failure, or perhaps insufficient in itself, and will in turn have to give place to some new method propounded by research, such as a simple but informing physical test. But such a possibility must not forbid its trial. In plain terms, what is required is a means of ascertaining the value of any iron for making castings and of obtaining in quantity an iron which will give desired and certain results.

Inherent Qualities.

Referring back, it is worthy of repetition that the same logic which forbids us to claim for analysis a complete power of control also forbids us to ignore the power that it does wield. Everyone who has handled analyses knows that samples with the same apparent chemical analysis may vary widely in character, but it is also known that mixtures made from irons with the same fracture may vary in character too. Seeing that there are other factors, such as blast pressure, etc., it is only natural that such samples should vary. These irregularities are chiefly due to the working conditions of blast furnaces at time of manufacture and casting of the pig-iron. For the same reasons various pig-irons, even of the same analysis and from the same district, will be found always to vary in character. It is true, too, that some pig-irons mix one with another better than others, a fact which has not yet been explained satisfactorily; but all these facts, detracting as they do from the value of analysis, do not destroy its value. The ultra-practical man uses them for this purpose, but amongst all the factors which influence

iron, the most important is undoubtedly its chemical analysis.

Casting Temperatures.

Next in importance, although equally ignored, is casting temperature. Ignored is not altogether meant, because it always has to be considered in its relationship to running and soundness. Little research on practical lines has been published, but strict attention to mixing and analysis shows that many irregularities in the past have been wrongly attributed to these latter factors, and compel attention to be given to casting temperature. Under this head occur those bewildering differences in the same heat of iron from the cupola, which in the main are certainly not due to differences in the iron itself, but often to the temperature at which it was cast. It has been shown in a Paper* on "Semi-Steel" that the tensile strength from very hot metal may be double that from cold of exactly the same composition, and this applies to all grades of iron. This important factor, however, appears to be more difficult to control than does analysis, for although melting temperatures may be regulated, this is by no means the same as casting temperature. This applies particularly to light snap-flask work, where each box weighs only a few pounds and a 5-cwt. ladle takes a considerable time to empty. It is not correct here to say that analysis gives no help in the solution of the problem. Without a knowledge of the analysis there is no certainty that these and other phenomena may not be due to variations in the iron; but if it be proved that the various samples are of identical analysis, then by a process of elimination attention is directed to other possible causes which may be proved, one at a time, to be varying or unvarying as the case may be.

The Importance of Phosphorus.

In any system of grading by analysis chief attention will naturally be paid to silicon, as this element exerts more influence on the iron than any other. So much is this the case that if iron could be obtained of guaranteed and required silicon content a sufficient trial could be made of the system of "grading by analysis" without regulating other elements; a trial which would enable the giving a verdict on its value, and in the event of its success would justify a grading throughout. Phosphorus, although an important element, is not a difficult one with which to deal, because its amount very rarely varies to an important extent in any one make of iron. It is because of this unvarying quality, and not because of the unimportance of its influence, that it causes little worry to the ironfounder, for knowing the required percentage of phosphorus in any class of castings this can be easily obtained. If other elements were as reliable, it may be concluded they would cause no more worry, and this is certainly an argument in favour of the analysis system. The subject of phosphorus is, of course, not to be dismissed in these few sentences, but the contrast between this case and that of silicon is in our knowledge of requirements. So much attention has been paid to this latter element that its influence is well understood and desirable limits for almost all classes of work are known fairly accurately. But more light is desirable on the amount of phosphorus which is best for heavy work, automobile work, and chilled castings, and it is from this side rather than the blast furnace that work must be done.

The Sulphur Question.

In the case of sulphur, this element is almost invariably best when lowest. There are those who lay every evil to its account, and others who maintain it to be almost harmless, whilst even again there are cases where, according to Longmuir, sulphur may be advantageously added to low sulphur Swedish iron. The field of foundry practice is so wide and diverse, and the classes of castings made by various workers so different, that it is possible that the adherents of both sides are right for their own practice. In the case of light castings where surface and skin are of the utmost importance and which frequently have to be machined all over, there is a very definite limit, and that not a very high one, beyond which clean, sound, easily machinable work cannot be made. For such work, the lower the sulphur the better, and it would certainly be beneficial if never over 0.06 per cent., although this does not mean agreement with the passing of iron through an electric furnace, to bring the sulphur down to 0.01 per cent. or thereabouts. In normal times the sulphur can with care be kept round about 0.08 per cent. and easily below 0.125 per cent., which can be considered the limit of safety. But from the commencement of the coal strike in April last there was practically no limit to the sulphur in foundry cokes, and it has been quite impossible to keep within bounds. It must be borne in mind that some foundry practice involves the use of 50 per cent. scrap, and sulphur therefore rapidly mounts up. It can be readily understood that in the manufacture of large castings on which no fine machining or finish is essential that sulphur is sometimes a good friend, because it increases combined carbon and hardness and hence tensile strength. Our experience has shown that with such high sulphur contents the tensile was usually above the average, and against this it must be borne in mind that the iron was often sluggish and rarely normally hot and fluid. The transverse, however, shows a decided decrease, showing that brittleness is also increased. Therefore, although there is such diversity of opinion, ironfounders generally will agree that the past six months, with its excessively high sulphur, has been an unusually troublesome period, and it is to be hoped that coke-makers will return soon to normal.

Cupola Slags.

In this connection some reference to cupola slags may not be out of place. The chief purpose of such slags is undoubtedly to gather together all the refuse found inside a cupola at work; separate this from the metal, and hence allow the latter to come away clean at the tap hole. Many slags, however, contain, besides unwanted refuse, too much iron and too much of the lining of the furnace, both being sources of waste. Comparatively little work has been done with regard to cupola slags, except that the cupola man studies its colour and nature and tries to relate these to furnace working. Surface colour is a very unreliable guide, but the powdered slag gives the true colour, and is far more informing. It is not desirable that in cupola working the slag should exert on the metal such an influence as it does in the blast furnace, converter and open-hearth furnaces, but there is one direction in which much more is desirable, and that is in the removal of sulphur from iron to slag. The very high percentage of sulphur now being met with in foundry coke is a matter of serious concern to the ironfounder, and a control of equilibrium between sulphur in metal and slag would be highly advantageous. The mere addition of limestone has a slight effect in this direction, but not an appreciable one when sulphur contents such as those just referred to are being handled. Manganese also has the power to carry sulphur into the slag, but this, too, is an inadequate remedy. As to "patent medicines" for this purpose, it has not been surprising to find that these expensive remedies fall far short of the claims made for them. Undoubtedly there is room here for scientific treatment of the problem.

An American worker, J. W. Bolton, has suggested that to increase the bulk of slag present may be an efficient means of reducing sulphur in the iron. If the slag made in a certain heat contains, say, 0.50 per cent. of sulphur, then if the total weight of slag be synthetically increased by 25 per cent., and the percentage of sulphur therein remains the same, then a greater weight of sulphur will be carried from the cupola by the slag, and less will remain for distribution in the iron. It is proposed to charge sand, limestone, etc., as the basic constituents for synthetic slag-forming, and at first sight this may appear cumbersome, unscientific and costly, but it may still be worth trying, for the total extra volume of slag to be melted would not be great. The same worker shows that high cupola temperature also helps in the same direction. This Paper,* which only came to my notice a few days since, appears to be an excellent one, and amongst the most informing on the subject, since it contains the results of technical work on a practical scale.

* "The Foundry Trade Journal," vol. 23, p. 201.

* "The Foundry," September 1, 1921.

The mode of occurrence of sulphur in coke and slag is very striking. In the case of the coke that sulphur present as sulphate is fairly harmless, and hence it does not follow that the coke highest in sulphur gives most of this element to the metal. Sulphur once in the slag as sulphate is probably there permanently, since calcium sulphate is not readily reduced under cupola conditions, but that present as sulphide probably may pass to and from the sulphide to sulphate form, and *vice versâ*, depending on the degree to which the cupola atmosphere is an oxidising one or otherwise.

A New Aspect of Chills.

Although in the production of light castings chill is one of the worst enemies, yet to many engaged in roll making the production of chill is the very essence of the business. So far as the use of chillers is concerned, every iron is a chilling iron to some extent, but there are, of course, ranges of composition which are most suitable for the work. In the cupola, too, almost any iron may be chilled to whiteness if maltreated, a fact which is, perhaps, better known by those who are trying to keep their iron soft. For the production of this class of work it was formerly the custom to use charcoal iron or cold-blast iron, but this is by no means so universal to-day. These irons are somewhat out of the ordinary in their analysis, principally with regard to total carbon, and they are not easily matched exactly in composition by modern hot blast irons. Also they possess physical properties of higher value than ordinary irons of approximately similar analysis. To a certain extent, the older irons owe their popularity to-day to a mistaken notion on the part of their users that no other iron can equal them, an exaggerated idea, which is supported also by the makers, as certainly they have been equalled by the "refined" irons on the market. It is certain that all cast-iron assumes its normal state when melted, and that any chill, closeness of grain or other distinct qualities do not reappear except from the cause which originally produced them in the pig. Light ironfounders, if they will have faith and take the risk, will find that iron which has been chilled until white by external causes, such as chillers, dampness, etc., and not by any change in composition, can be remelted under normal conditions and cast perfectly grey. It is, of course, only when the analysis is known to be that of a normally grey iron that it can be definitely said the chilling is due to external causes, and reference is only made to such. But if this be the case, it is not at all clear, and no reason has been yet given that will convince anyone who only believes what is proved, that cold-blast irons in the foundry are necessarily superior to other irons of similar analysis, such irons or the scrap from them being subjected to repeated remeltings in the foundry.

In no class of castings is there a clearer field for the use of analysis, and yet the chilled-roll industry has been singularly neglected. A chill may be perfectly hard and white, and yet be useless, for other properties are required of it, and unless a check be kept upon the iron in use such must not infrequently occur. Admitted that artificial chillers will always be essential, but the control of the depth and character of chill lie not so much with the chiller as with the iron. When deep chills are required, as in a large roll, it is necessary to resort to very low silicon of the order of 0.5 per cent., and in surveying the range of irons with such low silicon it is found that this is almost always accompanied by high sulphur, itself a chilling agent. The chill from high sulphur is weak and brittle, and ends abruptly, and is often associated with those hair cracks which in the end ruin a roll, and the surface is also often freely scattered with blow-holes. Sulphur should be kept low, but if the pig-irons are high in sulphur this is not possible, and there is room for low silicon irons, lower in sulphur than those now regularly obtainable in quantity. It is partly on this account that the possibility of semi-steel for this work should appeal, as the silicon may be reduced by steel scrap without effect on sulphur, and a somewhat different pig-iron used initially. Phosphorus is kept low, because this shortens the period of solidification, and hence aids chilling, and, of course, because high phosphoric iron is much more brittle. Manganese is advantageous, and although it is said that it is an expensive element to add, in the case of high-class rolls, this is a negligible factor, and manganese should certainly be present up to 1 per cent. A manganese chill, unlike that of sulphur, spreads out into the core of the casting in fibres, and the interior itself is always tougher when this element is present. The high total carbon of the charcoal iron is not easily matched, but when steel is melted with the pig the total carbon usually increases, contrary to general opinion, and here again we are faced by semi-steel, for high total carbon is an important factor, reducing the liability to contraction and also lowering the melting point, which, by reducing the range of solidification, causes an increase in chill. In high-class American chilled castings such as car wheels, which are so extensively made in the States, nickel and chromium are also used as additional chilling agents, chiefly on account of the strength they give to the iron.

Since the preceding remarks were written in August, two articles of note have appeared in The Foundry Trade Journal, which entirely substantiate my conclusions. The first one deals with chilled car wheels, and it is shown that whereas wheels which failed in service contained an average of 0.188 per cent. sulphur, those showing longest life had an average of 0.142 per cent. sulphur, and the wheel selected as having actual longest life only 0.120 per cent. There is much that is comparable in chilled wheels and chilled rolls, and experience in one should be applied where possible to the other. The second article relates to roll practice, and it is shown how essential it is if best results are to be obtained that sulphur in chilled rolls for hot rolling should be under 0.08 per cent., a figure unobtainable in low silicon irons, cupola melted, whether in this country or America. These articles are merely quoted in support of the statements already made.

Conclusion.

By these general considerations it has been the object briefly to show how far the control of composition may control the depth and character of chill, and although it is apparent that the production of these rolls is the task of highly skilled craftsmen there is much room for improvement and for a greater degree of certainty in the obtaining of successful results. It is my purpose not so much to instruct in the art of making chilled rolls as to open out for inspection the factors on which this depends, that those who to-day are neglecting such factors may view the field of the unknown.

In bringing this address to a close, it is apparent that in some respects the matters on which I have touched may be thought of only minor importance. It cannot, however, be denied that in considerations of quality the most important factor is the iron. Without good iron, good castings cannot be made, and the best of labour, effort and thought in other directions is merely thrown away. No amount of skill in other branches of the foundry industry can compensate for the deficiencies of the raw material used, or of the melted iron produced, and it is to these that attention should be called.

A New Feature of the "General" Moulding Machine.

In our issue of August 17 we referred to the "General" hand-operated moulding machine. The fact that this new machine was shown at the Shipping Exhibition at Olympia has given us a further opportunity of inspecting it. In addition to the other points mentioned, we notice that a new method is incorporated for straightening the pattern plate. By means of adjusting screws, which can be turned by the hand, a pattern plate which is not true, *i.e.*, one which is buckled at the end, can easily be made absolutely level; this is, of course, a very great convenience.

One particular pattern was demonstrated which was of a very deep circular shape, with wide radial cooling fins—a really intricate pattern which is very readily drawn by the "General" machine with ease and sharpness.

As previously mentioned, this machine is made by the General Foundry and Engineering Company, Limited, Lutterworth, Leicestershire.

Moulding and Belt Pulley in Halves.

By Arthur Greenhalgh.

The diameter of the pulley to be considered is 5 ft. with a driving face of 36 in., and is made in the floor. The arms, of which there are six in each half, are made in cores. The rim is rammed by means of a block working from a spindle.

A plate is necessary for lifting away all the arm cores together.

The first requirement then is the preparation of a hole of the required depth and diameter and the

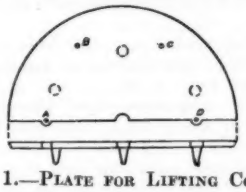


Fig. 1.—Plate for Lifting Cores.

fixing of the spindle. A bed is struck for the plate for lifting the arm cores. The plate should be made as in Fig. 1, A, B, C and D being nuts cast in the plate for lifting—eye-bolts being used for the purpose. The nuts B and C being placed so they will come between the joints of the cores. Three or four prongs are cast on the bottom to guide the plate back into position. The bed having then been made, the plate is placed upon it and bedded level. The bolts are taken out and the nuts plugged with hemp or waste to prevent the entrance of sand. Wet parting sand is then placed round the edge of the plate. All round is then rammed up, and on the curved side with facing

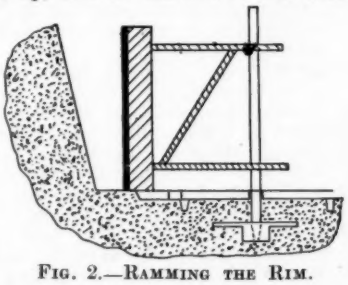


Fig. 2.—Ramming the Rim.

sand, as this is the bottom of the rim. It is then strickled off level with the top of the plate and well sprigged to prevent the plate disturbing it when it is lifted out. The block is placed in position and the ramming of the rim commenced, as shown in Fig 2. Seven and eight inches over the half should be rammed at each side; this, as can be seen afterwards, will easily be stopped off by cores used for this purpose. After the block has been rammed up about half way, it is well vented to the bottom. A layer of ashes is placed over the vents. It is then rammed and ironed to the top and again vented down to the ashes. The joint of this section is now made, and when this is

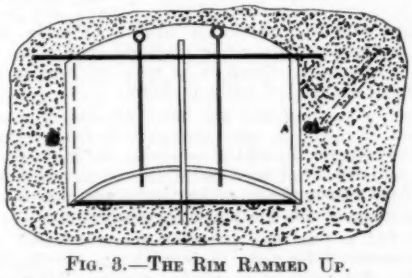


Fig. 3.—The Rim Rammed Up.

finished, the block is swabbed and rapped. The block is then moved round; this process is continued until the whole is rammed up, the ashes being connected each time and trailed to a pipe. Fig. 3 shows the rim rammed up.

The plate is now swept clean and the bolts placed in the nuts ready for placing the arm cores in position. Before the cores are put on the plate the exact half of the pulley is found. This is carried out in the following manner:—A spindle straight-edge is placed up to the spindle along the joint and one in the bottom; a plumb-bob is suspended from the top to the bottom straight-edge to ensure that they are exactly parallel. Lines are then drawn from the top to the bottom on the face of the mould as indicated at A, Fig. 3. Each arm core is made separately, and dried, in order that they may be better to handle. The difference between top and bottom set of cores is that the bottom set covers its own boss, whilst the top boss is covered by a small loam cake. The two outside bottom cores can now be placed in position, one on each side of the spindle, square with the vertical lines which have been previously drawn on the side of the mould. The middle arm core is now placed in position. The air from the cores is brought up between the handles or staples of the grid by means of a peg around which is rammed black sand. This peg is afterwards withdrawn and the hole filled with small ashes. The three

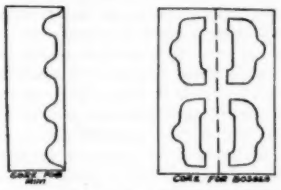


Fig. 4.—Cores for Rim and Bosses.

cores should also be fastened together at the staples, either by means of a clamp or bolt; this will prevent the risk of any of the cores being disturbed when the plate is being lifted out.

The second set of arm cores can now be placed in the mould, after the manner of the first set, the vents being carried right to the top and the staples fastened in the same manner as the bottom cores. A runner connects the two bosses, which helps to feed the bottom boss. Having ensured that the cores are fast together and the vents made correctly, the whole of the cores can now be lifted away together. Screw chains are the best for this on account of their ease of regulation. After they are lifted away, the joints of the cores are made up on the rim and in the bosses. The sides of the cores are tried with a straight-edge to see that they are level. It may be necessary to rub them a little to square them up, afterwards the whole of it is blacked and placed in the stove.

The bottom part or rim then receives attention. The top joint is made good and also any portion of the bottom, which the plate may have pulled up. This is then blocked and sleeked and is ready for fixing. Whilst the core and the rim are drying, a top part can be rammed up; this being flat, will not take much time, for it is not necessary to ram up the whole box, and that portion above the boss can be left open. After the bottom has been dried thoroughly, it is cleaned out, the core brushed down and any dirt in the arms blown out. The core is then placed back in its position

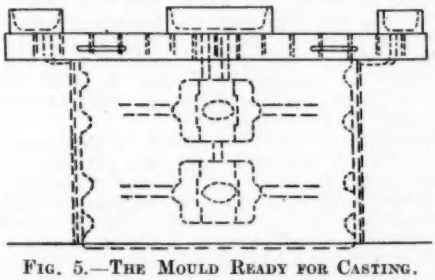


Fig. 5.—The Mould Ready for Casting.

in the mould. The centre core can now be tried; this, of course, is only half, running through both bosses. When this has been fixed, the stopping-off cores for the rim and boss can be placed in position. These cores contain the planning pieces to correspond with the boss and the lugs for bolting the two halves together. These cores are shown in Fig. 4.

The stopping-off cores are now made secure and the back rammed up with black sand. When the joint has been levelled off the top is tried on and holes made through for the vents in the core. The core on the top boss is fastened down by wedging to the top part. When the top has been put back, the runner and risers are made up, the top weighted, and the job is ready for casting.

A section through the completed mould is shown in Fig. 5.

XUM

Foundry Reorganisation.– Part V.

By H. W. J.

Some foundries endeavour to persuade the customer to leave the matter of patterns in their hands, by pointing out the advantages which will accrue by way of cheaper castings. Obviously, if the customer is to yield, he must have some incentive, and so the onus is upon the founder to show that his quotation for castings (which includes the making of the necessary patterns) is competitive with the quotation of others who are not prepared to make patterns.

In other words, the worth of the patterns must be given to the customer, and if it is worth the founder's while to suggest that he makes the patterns, it is worth his while to do so without extra charge. He expects to make something out of it, otherwise he would not make the suggestion, and this being so, it is a bad move to make the suggestion and then expect the customer to pay.

All this is very well if no pattern is in existence, but suppose that the customer has a whole range of patterns, which he himself has made, and which have hitherto done duty in another foundry. The customer does not look upon them as scrap, and he is certainly averse to having them replaced at his own expense.

Many customers think they know more about their product than does the founder, and they hesitate at placing the order for patterns in his hands. Rather would they employ a pattern maker, and have the pattern made under their own supervision. By so doing, they feel that, so far as instructions are concerned, the whole of the product is in their own hands, and for such thoughts they cannot be blamed.

The customer does not think that economical working is his affair, and he does not trouble about the fact that all pattern makers do not see eye to eye when interpreting a drawing. He gives his pattern maker certain instructions, and when the pattern is completed he is convinced that it is good enough for anybody, and he cannot understand why the foundryman is not as enthusiastic over it as he is.

Another point is that the customer does not like to think that he is tied to one foundry, but the fact that the foundry is making the patterns free of charge suggests that at the expiration of the present contract a further one must be given, or another foundry asked to undertake the making of patterns, which in all probability it is unwilling or unable to do. This being so, the customer must either make patterns himself, or place a fresh order for castings with the foundry which is responsible for the patterns already in existence.

It is, of course, the wish of the founder to tie up the customer, if it is at all possible, for he is not making those patterns wholly and solely for the immediate order. He knows that the order he holds does not represent the beginning and the end of the product, and he is after the orders to follow. That is one of the reasons why he wishes to make the patterns—he wants to give good service at an economic figure, in order to retain the goodwill of the customer.

Inducements must be offered to the customer before he will consent to allow the patterns to be made by the founder, and it is well, therefore, to be honest with him. It is a bad plan to accept patterns from the customer, ostensibly for use, and then to make other patterns to facilitate working, without notifying him of the intention. Sooner or later he will find out, and he will consider it a breach of faith. It is quite possible that he will retaliate by finding faults in the castings, and though, no doubt, these can be refuted, a certain amount of bad feeling is engendered, which augurs ill for amicable working in the future.

Whenever the prospective customer proffers patterns, it is the duty of the founder to advise him of any alternate method which will yield better results. It may be that loose patterns are sent, and a plate pattern is recommended. The advantage to the customer that the suggestion would offer would be reflected in the quotation, both in regard to price and delivery, and this would carry more weight if an alternative quotation (for the castings off the loose patterns) were given.

The customer, as a rule, will not pay for the plate pattern, for he argues that this is of value only whilst it remains in that particular foundry. It would, perhaps, be well if plate patterns were standardised, so as to be acceptable in any foundry.

The foundry may decide to accept the customer's pattern and use this for the purpose of making its own plate patterns, the necessary allowance for contraction, of course, being made. Assuming the pattern is but a small one, so that many may be accommodated on one plate, it may be decided to utilise one plate for more than one type of pattern. If so, the customer's requirement of each must be considered, not only the present, but the future.

One foundry made up a plate, this comprising six patterns of one type and six of another, but when investigations were made, it was discovered that the customer's requirement of the first type was double that of the second, although his order did not convey this impression.

If the customer makes his own patterns, he feels that he can, at any time, effect any alteration he so desires, and this is an important point for him. He is quite annoyed when his suggestion for an alteration is protested against by the foundry, whilst, if the protest is not made, the founder may find himself involved in considerable expense. A suggested alteration led to the discovery that a certain foundry had for some time been working off a plate-pattern, although only loose patterns had been supplied by the customer.

In the interests of economy, it is perhaps advisable to persuade the customer to allow the founder to make the necessary patterns, no charge being made when the customer already has patterns. Where no patterns are already in existence, a charge could be made if, at the completion of the contract, the patterns become the property of the customer.

Assuming that this is agreed upon, it may be that, so far as loose patterns are concerned, woodworking patterns are used, for the founder can obviously determine better than can the customer what patterns will prove the more economical. It will be well, however, not to refuse outright the customer's offer of patterns, otherwise it is to be feared that good business will be lost.

The founder's pattern shop must be capable of meeting the demands made upon it, and it is essential that a thorough understanding exists between the pattern-maker and the foundryman. future orders for castings are fairly well known, must work in complete accord, in order to ensure economical production and satisfaction to the customer. If the customer has suggestions to offer, do not attempt to discourage him, for he may tell you something worth knowing. On the other hand, your advice and kindly counsel may be of help to him, and it will not be unprofitable to you.

We may assume then that our foundry boasts of a pattern shop—that as far as possible we make the patterns to the customer's blue prints, but that we are prepared to cast off the customer's own patterns. Our pattern store is so arranged that all patterns are easily identified and are easily obtainable. No pattern is received therein until it has been certified as in working condition, and if a customer's pattern is in need of repair, that customer is notified without delay.

Customers' patterns are not held after the completion of contract, even though it is fairly certain that a further order will be received. We make a hard and fast rule that such patterns are returned with the final consignment of castings, and the fact is duly recorded on the pattern records.

So far as our own patterns are concerned, circumstances determine their ultimate destination. Before the pattern is made, the possibilities of future orders for castings are fairly well known, and at the conclusion of the contract, the pattern, if still in good condition, is kept in the store pending further instructions.

Obviously, the estimated extent of future business determined to some extent the construction of the pattern, and if optimism prevailed, the pattern was made to last. If, on the other hand, the prospects could not be regarded as hopeful, then the pattern was made to do just what was required of it.

The New "Ford" Foundry.

(*Continued from page* 318.)

Making the Moulds.

The moulds for the cylinder blocks are made in green sand on two batteries of moulding machines made by Henry H. Pridmore, Chicago, one battery on each side of a drag-type conveyor, as shown in Figs. 1 and 2. It will be noted that the outside conveyors travel toward the pouring stations while the centre conveyor moves toward the shake out station as indicated by the arrows. Each conveyor is driven by an individual 10-horse-power motor manufactured by the Westinghouse Electric & Manufacturing Company, Pittsburgh, and is connected through a set of reduction gears to a picker belt chain provided with fingers at regular intervals which engage one of the cleats on the bottom boards of the flasks. The group of men making the moulds is spread out in a long line on both sides of the conveyor, but as one side is an exact duplicate of the other a description of the method employed on one side will serve for both.

The drags are rammed by hand on a battery of six rollover, pattern-draw machines with three men to each machine. Each man has a definite number of motions to make, but they alternate at intervals during the day to distribute the burden

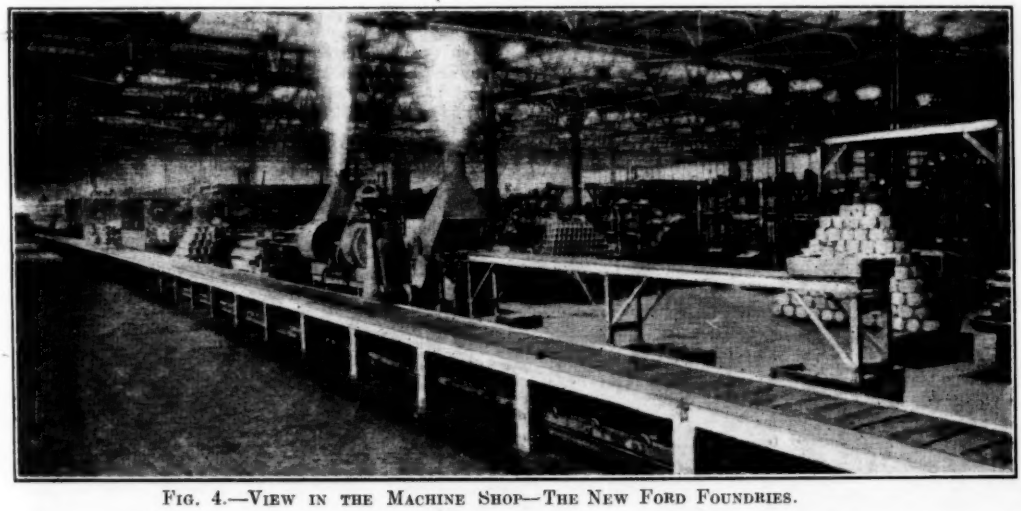


Fig. 4.—View in the Machine Shop—The New Ford Foundries.

in an equitable manner. Each moulding machine is placed directly under a sand chute, and is filled by opening a gate within easy reach of one of the operators. Two men ram the flask and lift it on and off the machine. The third does what little necessary finishing is required, and brushes blacking over the face, then, with the aid of one of his companions, he sets the drag on the conveyor.

Once on the conveyor the drag passes along before a number of men, each of whom contributes his quota toward a complete mould. The first sets the housing and port cores, the second tries a gauge on these cores, and then sets the gear case core; the third blows a jet of air through the mould to clean it out and then sets the housing core chaplets. The next sets and gauges the water jacket core, and the following workman sets the body or barrel cores and by small checks tallies the number of moulds as they go by. Each moulding machine bears an individual number, and in this manner a check is kept on the output of each one. The last man in the group tries an overall gauge on the cores, and by that time the mould has arrived in front of the cope machines.

The Pouring System.

The copes are hand rammed on a battery of six stripping plate machines by three men on each machine. After throwing a handful of facing over the pattern, one man sets a 5-in. spike in each hanging pocket, while the second sets the runner core and gate pin on the centre of the back flange. The runner core is merely a small block of sand about 1 in. thick, with an oblong hole through the centre and rests upon a small lug on the pattern provided for that purpose. In this manner no danger exists for the gate pin to shift under the influence of the rammer and also there is no danger of the gate edges washing away under the force of the falling stream of iron.

This method of pouring a cylinder block through one small pop gate directly above the bottom of the completed casting is radically different from the elaborate pouring and gating systems in vogue in other foundries which handle this class of work. That it is satisfactory is evidenced by the fact that it has been in use for years by this company, and it is claimed that the cylinder losses from all causes average below 10 per cent.

After the gate pin is pulled out of the rammed cope one of the men sprinkles a little blacking around the hole and then drops a tapered mushroom-shaped plug in the hole and gives it a turn. This reams out and smoothes the top of the sprue. The castings are poured without risers. The copes are placed on a platform alongside the conveyor as they are made, and two men walk back and forth setting them on the drags. Long pins extending through upper and lower lugs on the cope flask ends are employed for guiding the copes into place on the drag flasks. The pins are not removed until after the mould has been poured and is on its way back on the centre conveyor.

A man standing between the inside and outside conveyors knocks the clamps off the poured moulds as they return toward the shake-out and places them within reach of a second man who lays four on top of each freshly closed mould. This man also sets the back plate up against the open side of the flask. A third man places a piece of paper over the sprue, then sets a runner box and four wedges on top of the cope. Two men clamp the flasks. The two clamps on the outside in addition to holding the cope and drag together also hold the back plate firmly in place. For the benefit of those not acquainted with the Ford cylinder it may be stated that one side of the cope and drag in which it is moulded is cut out the full size of the rectangular body core print. This method was adopted to facilitate setting the body cores in the mould, but these cores do not fit tightly enough to prevent iron from leaking through, and therefore it is necessary to set a flat plate across the opening after the mould is closed, and pack the space between the end of the core and the plate with sand.

Pouring the Castings.

One man throws a few shovels of sand into the space between the back plate and the core and a second rams it. Two men ram the runner boxes. One man sets an iron block provided with a handle in the centre of the box and rams the sand which the other shovels in. No attempt is made to sleek around the top of the runner, the workman simply pulls out the block and sets it in the next runner box. A workman, provided with an air hose, blows all the loose sand out of the runner and then the

XUM

mould is ready for the iron. The iron, which is melted extremely hot, is brought from the cupolas in 1-ton ladles hanging from chain blocks made by the Yale & Towne Manufacturing Company, Stamford, Conn., and suspended from a 12-in. I-beam monorail. One man operates the chain hoist and a second operates the geared ladle.

After the moulds are poured they travel to the end of the conveyor where a double pneumatic device operated by two men pushes the moulds from each of the outside conveyors on to the centre conveyor. The centre conveyor, as indicated by the arrows in Fig. 2, travels in the opposite direction to the outside conveyors and carries the moulds to the shake-out station. The centre conveyor is covered by a sheet-iron hood, and travels over a grating through which all the smoke and gases are exhausted by a powerful suction fan and discharged through stacks extending above the roof.

The flasks are shaken out over a grating in the floor at the end of the conveyor and then placed on the outside conveyors, which take them back to the moulding sations. The castings are loaded into iron pans, and by means of a 5-ton crane, manufactured by the Milwaukee Electric Crane & Manufacturing Company, Milwaukee, are taken to the second floor, extending back from and over the centre gangway. Here they are allowed to cool before the cores are knocked out. However, as the supply constantly is arriving and as constantly departing, it is obvious that a sufficient supply of cold castings always is available. In the second moulding unit the castings are taken to the second floor on an endless conveyor, but sufficient data are not yet available to determine which is the more economical method.

The sand from the shake-outfloor falls through a grating into a hopper, from which it is lifted by a bucket elevator and discharged into a revolving screen set at a slight angle and provided with openings at each end. The sand enters at one end, and the centrifugal force throws all the scrap and hard lumps out through the other end. The sand passes through a beater which reduces it to the proper temper, and then it is discharged upon a conveyor of the scraper type operating over the chutes leading to the various moulding machine stations. A heavy steel bar suspended at the point where the scraper blades start on their horizontal journey is lifted by each blade passing under it. As the blade passes from under the bar the latter swings back and strikes the succeeding blade a sharp blow which effectually loosens any adhering sand. A gate is provided over each chute, by which the supply of sand may be cut off at any time from any individual machine.

Gratings are provided in the floor in the vicinity of each machine through which the surplus sand is shovelled on to a belt conveyor which takes it to the mixing station and incorporates it with the sand from the shake-out floor. Any sand left in the overhead conveyor after it has passed the various chutes is discharged over the end on to the floor. It is allowed to accumulate for a while and then is shovelled through a grating on to the conveyor belt already mentioned. A small portion is retained, and in conjunction with a little new sand and coal dust is passed through a paddle-type mixer and used for facing sand. A similar system is provided for reclaiming the spilled sand in the core-making department.

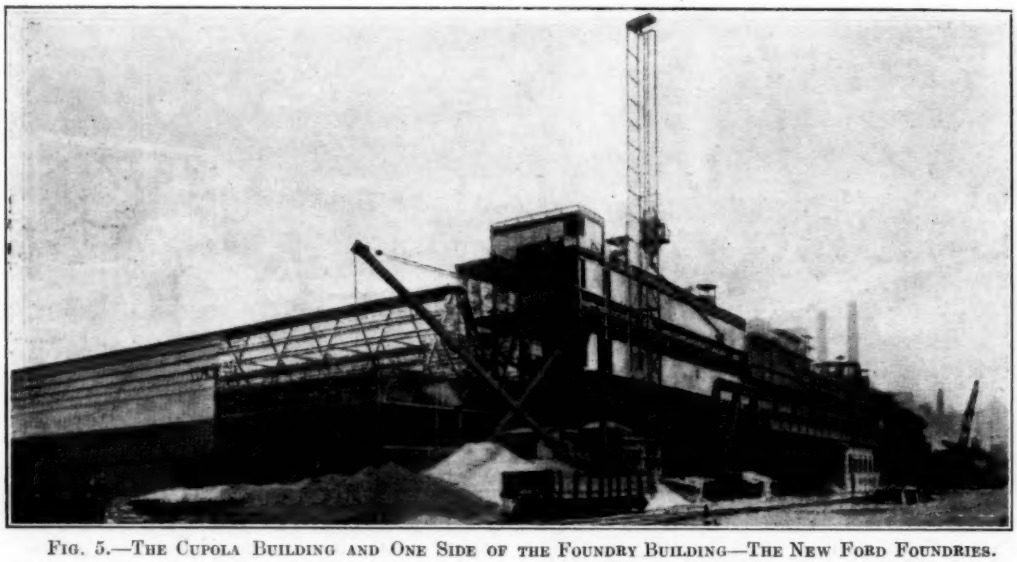


Fig. 5.—The Cupola Building and One Side of the Foundry Building—The New Ford Foundries.

Cleaning the Castings.

From the pans the castings are lifted on to a stand where two men provided with long, pneumatic hammers punch out the barrel core arbours. The castings then are pushed on to a pair of parallel rails resting on a grating and other workmen with sharp bars remove almost all of the core sand, which falls through the grating into a revolving riddle that reclaims the greater portion of it. The castings then are loaded on trucks and taken down on a 3½-ton elevator to the ground floor and loaded into one of the myriad of tumbling barrels. From the tumbling barrels the castings are taken by trucks to the chipping stands, which also are arranged on the continuous system. A row of men stands alongside each stand and each chips his allotted part of the casting and then pushes it on to the workman at his right. From the chipping stands the castings are loaded on to trucks, and after three or four trucks are loaded a gasoline tractor is hitched on and hauls them to the shipping platform outside the building. The machine shop at the River Rouge plant is not yet in operation, and therefore all the castings are taken to the Highland Park plant of the company for testing and assembling.

The light work conveyor shown at the left of Fig. 2 is equipped with twelve moulding machines supplied by the Berkshire Moulding Machine Company, Cleveland, but has not been placed in operation up to the present. No. 2 cylinder moulding unit is equipped in a similar manner to No. 1, with the exception of the conveyor for the castings already mentioned. Another point of difference is that one of the sand-throwing machines, made by Beardsley & Piper, Chicago, has been installed for making the copes of the cylinder moulds. The drags are made of six roll-over, pattern-draw machines, also made by Henry E. Pridmore, Chicago, as in No. 1 unit. Data are not yet available on the comparative merits of the two systems. In this connection it is interesting to note that the production on No. 1 unit is approximately 2,400 cylinder blocks on each eight-hour shift, and it is expected that this production eventually will reach 3,000.

Melting Equipment.

The immense tonnage contemplated in this big foundry may be gauged from the fact that 24 cupolas, each with a 78-in. shell lined to 60-in. diameter, will be erected. They will be arranged in three groups of eight, of which the first group already is in operation. The entire number will be provided by the Whiting Corporation, Harvey,

Ill. The exterior of the cupola building, comprising three units is shown in Fig. 3 with the first unit complete. The two stacks shown above the roof serve eight cupolas, four to a stack. The shells of the cupola extend upward only to the fourth floor, where each group of four discharges smoke, gas and sparks into a large steel muffle chamber. The gases pass off quietly through one of the stacks shown extending above the roof.

A wide plate continuous conveyor, running flush with the fourth floor, deposits coke and limestone in a number of bins suspended between the fourth and the third floors. The discharge ends of these bins or hoppers are within easy reaching distance of the men on the third floor, and are placed directly above a narrow-gauge track upon which the coke buggies are pushed back and forth. Two charging chutes, one on each side, are employed to convey the greater part of the charge into each cupola. The tops of the chutes extend above the third floor and are located between two narrow-gauge tracks, while the discharge ends open into the cupola a little above the second floor level.

Scrap, sprues and defective castings are loaded into dumping trucks, and taken to the third floor on two 3½-ton elevators. From the elevators they are pushed over the chute openings and dumped. Coming into the cupola from both sides helps to distribute the charge in a fairly uniform manner. Additions of steel, foreign scrap and a limited amount of pig-iron are charged by hand in the usual manner through a doorway placed just above the second floor; or what corresponds to the regular charging floor in most foundries. An elevated passageway, situated above the floor between two moulding units, connects the floor on which the castings receive their preliminary cleaning with the second floor in the cupola-room. All the scrap from the shake-out floor and cleaning floor is conveyed across this passageway in dumping pans running on narrow-gauge tracks.

In practice, due partly to the silicon content of the blast furnace iron varying from time to time, and due in a greater extent to the fact that the iron must be poured at an exceedingly high temperature, the amount of furnace metal varies from 33 to 50 per cent. of the total mixture. The blast furnace is tapped every four hours, commencing at 7 a.m., and at each tap one ladle of metal is taken to the cupolas. The remainder is taken to a pig-casting machine.

The ladle of iron mounted on standard gauge trucks is shunted under a ladle-tipping device shown at the top and centre of Fig. 3, made by the Wellman-Seaver-Morgan Company, Cleveland. Here the iron is transferred to a brick-lined steel container mounted on a truck running on a standard-gauge track extending through the cupola building from side to side and terminating at a point under a monorail and in line with the ends of the battery of eight cupola spouts, four on each side. The container is completely enclosed with the exception of a round hole on top near the back and a second opening near the top in front, which serves as a spout through which the iron is poured into the 1-ton ladles used to pour the castings. After the iron is poured into the container, the hole on top is covered with a brick-lined lid to help to maintain the temperature of the iron. A man stationed in a cage suspended from the beams close to and in front of the monorail, operates an electric hoist which raises the back of the container and permits the iron to run into the ladle suspended from the monorail in front of the spout.

A 2-ft. section of the monorail in front of the container and a similar section in front of each cupola is supported independently on a scale which registers on a large, easily-read dial the amount of iron going into the ladle. In this manner the relative amount of direct and cupola metal going into each ladle easily is controlled. The silicon content of the metal in the ladle is set at 2.64 per cent. The metal from the blast furnace ranges from 2.50 to 3.50 per cent. The analysis of each ladle of blast-furnace metal is received at the foundry shortly after the iron has been tapped and the cupola charge is adjusted to meet the desired conditions. As stated before, the temperature of the blast-furnace metal is a factor to be considered. When it is quite hot a correspondingly less amount of cupola metal will be required to bring it to a proper pouring temperature than when it is cold. The required amount of direct metal is poured into the ladle first, then the ladle is placed in front of the cupola spout and the remainder of the metal tapped into it. A small handful of aluminium is thrown into the ladle while the cupola stream is running. It is claimed that this treatment deoxidises the metal and renders it more fluid. From the cupola the metal is conveyed on a monorail to the various pouring stations and poured into the moulds.

A small pig-casting machine has been erected in the open space in front of the cupolas into which any cold iron left in the ladles is poured. At present three cupolas, melting 75 tons each, are used on the shift from 7 a.m. to 3 p.m., and one cupola melting 90 tons is used on the shift starting at 3 p.m. when only one moulding unit is in operation. The three cupolas used during the day are picked out, daubed and made ready at night for the following day's run. The cupola used during the night is made ready during the day preceding. The other cupolas in the battery are all bricked up and held as spares.

Iron and Fuel Ratio.

On account of the exceedingly hot iron required and the length of time the cupolas are in blast, it has been found advisable to use both upper and lower tuyeres. This practice necessitates a high coke bed, in this case 44 in. above the lower tuyeres. However, considering the amount of iron melted during each heat, the extra amount of coke used in the bed becomes a negligible factor. The succeeding charges are made up in the proportion of 400 lbs. of coke to 2,400 lbs. of iron.

Blast is furnished each cupola at 14 ozs. by a positive pressure blower supplied by the B. F. Sturtevant Company, Boston, driven by a 75-horse-power motor. These blowers discharge into a common main and the blast may be diverted from one cupola to another. The blowers are housed in the small building shown attached to the main cupola building in Fig. 1. Part of this building is devoted to daubing the ladles, and is provided with the necessary supplies and appliances for this purpose. The flat roof is enclosed by a steel curbing 4 ft. high, and is provided with a number of bins holding steel and iron scrap and pig-iron of various compositions. About 10 per cent. steel scrap is used in each charge and the pig-iron is used in varying amounts depending on the chemical content of the blast-furnace iron. Slag from the cupolas runs directly into four-wheeled iron trucks, which, when filled, are hauled to one of the elevators and taken to the second floor. Here they are taken out on the roof of the blower building and allowed to cool. Afterward the slag is dumped through a chute into a waiting railway truck. The ladle-tipping device shown in the same illustration is mounted on a special wide-gauge track and is available for use at any one of the three batteries of cupolas.

The bay between two rows of columns, as indicated in Fig. 1, has been set apart and fitted up as a jobbing foundry for the manufacture of a miscellaneous line of castings ranging in size and weight from washers to blast-furnace slag ladles. The equipment includes, among other items, a concrete-lined casting pit 16 ft. square and a 10-ton electric travelling crane. An electric furnace made by the Electric Furnace Construction Company, Philadelphia, the American house of Messrs. T. H. Watson & Company, of Sheffield, is installed near one end of the bay, and will be utilised to furnish the metal for the steel castings.

During the erection of the building and during the erection and installation of the equipment, the company maintained a fully-equipped machine shop, structural steel shop, and sheet-iron and tin shop on the premises.

The tools and equipment necessary for the manufacture and erection were not attached to permanent foundations. They were first placed near the centre of the building and moved along as the work progressed.

A Correction.—Mr. E. Adamson, of Sheffield, draws our attention to a printer's error which appeared on page 234 of our issue of September 22, wherein a temperature of 1,800 deg. Cent. is made to read 2,800 deg.

Concrete Results from Research.

No better propaganda could be given to the British Cast Iron Research Association than the diagram of average tensile tests of American malleable iron which we reproduce below. A writer in the "Iron Age," commenting on this diagram, which was contained in a bulletin issued from the office of Enrique Touceda, Albany, N.Y., consulting engineer for the American Malleable Castings Association, states that it throws an interesting light on the results of consistent research work covering a period of years, the value of which has been particularly demonstrated during the past three or four years.

Those who have kept in touch with the commendable work fostered by the Association in the improvement of malleable castings will recall the unhealthy condition in which the malleable industry found itself some seven or eight years ago. Except in a few cases, there was at that time no such thing as individual uniformity, either in manufacturing methods or in the resultant product of different malleable foundries. This condition was due largely to the lack of authoritative information on correct metallurgical practice, a haziness and uncertainty concerning air furnace and annealing oven construction, coupled with a secretive policy pursued by those plants which were making some progress through their own efforts at research.

Foundries that were still working in the dark continued to turn out a product lacking in all the qualities possessed by the better grade malleable castings obtainable to-day, and one that was little better than grey iron in ductility. The result was that the inferior product, in many cases malleable in name only, repeatedly proved its unworthiness in service, and cast a suspicion and stigma on all malleable castings, regardless of quality.

But the foresight of the Association saved the industry from impending disaster, for, some years after its organisation, a competent engineer and metallurgist was commissioned to inaugurate and carry on an intensive research programme. As fast as this work bore fruit, the findings were disseminated among the member plants in the nature of recommendations for alterations in general plant practices, and great improvement in the physical properties of malleable iron has resulted since that time.

Malleable castings as at present manufactured, in conformity with Association standards, instead of being of uncertain quality and lacking in uniformity, are of high quality and integrity. They are said to be on a plane of dependability the equal, if not the superior, of the best mild steel casting or forging, while they can be machined at almost double the speed of either.

The Improvement Shown.

The most marked advance in development has been made in the past 3½ years, during which period the ultimate tensile strength of the product of Association members as a whole has increased from an average somewhat under 21.8 tons per sq. in. to over 23.6 tons, and from an average elongation under 10 per cent. in 2 in. to nearly 16 per cent.

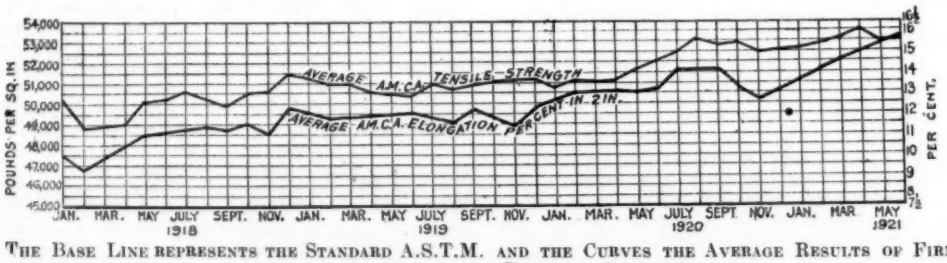
Reports of bars tested by the consulting engineer for the month of June, in the bulletin referred to in the opening paragraph, show the highest average percentage of elongation of the Association as a whole was attained, 15.77 per cent. in 2 in., or over twice the elongation required by the American Society for Testing Materials in its standard specification for malleable cast iron. Since elongation, which is the measure of ductility, is the property on which malleability depends, it will be seen that this report marks a new high level in the research programme. Since the first of the year the rise in percentage of elongation has been steady and uninterrupted and has increased a full 2 per cent.

High-water mark for average ultimate tensile strength was reached in April of this year, when the figure of 23.9 tons per sq. in. was recorded. The June value for this property was 23.7 tons, which is in excess of the A.S.T.M. requirements by slightly over 3.5 tons.

Reference to the chart, showing average ultimate tensile strength and elongation for the product of the membership as a whole, for 1918, 1919, 1920, and the first six months of 1921, indicates clearly how these two properties have increased during this interval. The average of both properties has always been well in excess of the A.S.T.M. standard requirements of 20 tons per sq. in. tensile strength and 7½ per cent. elongation in 2 in. It is clear that this margin, when added to the factor of safety already included in standard specifications, offers exceptional safeguards to the user of those malleable castings furnished by a majority of the members of the Association.

The Reason for the Variation.

The constancy in the average values of these properties maintained throughout 1919 and the spring of 1920, with little apparent improvement over a period of several months, is readily accounted for by the fact that during that time 22 new plants were added to the list of test-bar contributors. None of these had previously profited by the research work, and their submitted test bars in most cases had the effect of lowering the general average of the Association until the effect of the new influence began to assert itself. The same effect was felt from August to December of 1920, when four new contributors were added. No new contributors were added from April to August, 1920, nor from December, 1920, to June of this year.



THE BASE LINE REPRESENTS THE STANDARD A.S.T.M. AND THE CURVES THE AVERAGE RESULTS OF FIRMS ATTACHED TO THE AMERICAN RESEARCH ASSOCIATION.

This fact, taken in conjunction with the improvement in quality of the new contributors through the assistance of the consulting engineer and his corps of visiting inspectors, had the effect of a steady and rapid increase in both physical properties. The slight retrogression in the average values of both properties, marked by the dropping of the curves from August to November of 1920, is explained by Professor Touceda as having been due to the serious handicap experienced by the foundries in getting good pig-iron and coal during that exceptional period of demand for all commodities.

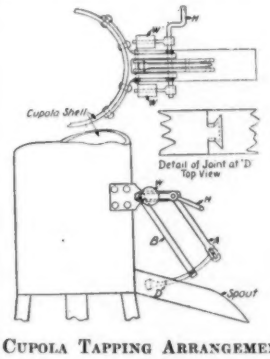
Another interesting fact revealed by the bulletin is the high percentage of perfect scores made by members of the Association. By a perfect score is meant the ability of every bar submitted by a member to equal or surpass the standard specifications of 20 tons tensile strength or 7½ per cent. elongation in 2 in. In June of the present year 87 per cent. of the contributors made perfect scores. Comparing this record with those for the same month of the previous years, we find that perfect scores were attained by but 29 per cent. of the contributors in June of 1918, 57 per cent. in 1919, 74 per cent. in 1920. Out of a total of 31 contributors in June, 1918, of whom 29 per cent. attained perfection, all but one made perfect scores in June of the present year. Only 2.53 per

cent. of all bars cast and submitted for test during June failed to pass the standard A.S.T.M. specifications, as against 15.12 per cent. for June, 1918.

This general improvement of the product of all members is reflected in the number of certificates that were awarded by the consulting engineer for the quarter ending June 30; 61 plants having been awarded the coveted certificate, the highest number yet issued for any quarter. The awarding of a certificate is not based upon the test-bar record alone; the general plant practice, as reported by the consulting engineer's corps of inspectors, being considered in its effect upon the product. Through this safeguard the purchaser is assured that the test-bar record of each day's production can be considered as truly representative of the castings. Castings made by certificate-holding plants are called "certified" malleable castings.

A Cupola Tapping Device.

A mechanical bod-stick for opening and closing the tap-hole is fitted to each of the cupolas in the new grey iron agricultural implement foundry of Fried Krupp A.G., at Essen, Germany. Its construction is shown in the accompanying illustration. A saddle bracket riveted to the cupola shell about 3 ft. above the spout carries two pairs of links, *A* and *B*, which have their upper ends pivoted on short shafts. The shaft connected to link *A* is extended and fitted with counter-weights, *W*, and a crank handle, *H*. The lower ends of the links carry the bod-stick, which is curved, as shown in the illustration. The bod-stick is pivoted on the lower ends of the links *B*, but a sliding connection is provided with the links *A*, and both pairs of links are so proportioned kinematically that the lower end of the bod-stick,



A CUPOLA TAPPING ARRANGEMENT.

carrying the clay ball or spear, as the case may be, moves horizontally.

The bod-stick is provided with removable end-pieces, which are connected to the main part of the stick by means of tapered dovetails as shown at *D*, and in the enlarged sketch of this connection. Some of these end-pieces are sharpened to form a spear or punch for breaking out the tap-hole at the beginning of a cast. Others have flat ends to which the clay balls are stuck. Several of the latter with the clay balls ready prepared are kept on hand for instantly cutting off the flow of metal if emergencies should arise.

This device is positive in action and there is no difficulty in stopping the most active cast, or in boring out a refractory tap-hole. One man operates the device usually with one hand on the crank handle. The counter-weights are sufficiently heavy to pull the links out of the way when the device is not in use. The danger of being burned from splashes of molten metal is eliminated, and this is stated to be one of the greatest advantages of the device, coupled with the fact that the flow of metal is under absolute control and that the over-filling of ladles is obviated.

THE production of graphite in Japan during 1920 totalled 1,259 short tons. Other output figures were:—Chromite ore, 4,364 short tons; manganese ore, 6,019 tons; tungsten ore, 174 tons; and crude molybdenite, 98 short tons. Pig-iron produced amounted to 168,129 metric tons.

A Flask of Novel Design.

A good flask must satisfy the following conditions:—(1) It must fit properly any kind of mould; (2) it must be strong without weighing too much; (3) it must always be ready for use; (4) it must occupy little space when stored; (5) it should serve a great variety of purposes. All these conditions are satisfied in the case of a flask designed by Herr Malzacher, of the Traisen-Leobersdorf Company's steel foundry in Lower Austria, and shown in Fig. 1.

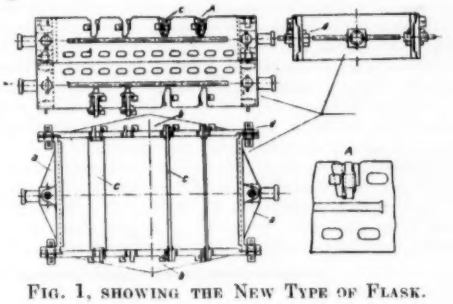


FIG. 1, SHOWING THE NEW TYPE OF FLASK.

The flask consists of two head-pieces *a* and two side-pieces *b* with suitably shaped ends to form a good joint; they are held together by bolts and gibs. The details of the joint are shown in our illustration. The slope of the two gibs is in opposite directions, and is at a very flat angle, so that the flask can readily be put together or taken to pieces with a tap or two of a hammer. This kind of connection has proved quite serviceable even when the flask was dealt with on a jar-ramming type of moulding machine.

The cross-ties *c* consist of flat pieces, those at the bottom serving at the same time as base plates upon which the flask rests. The way they are

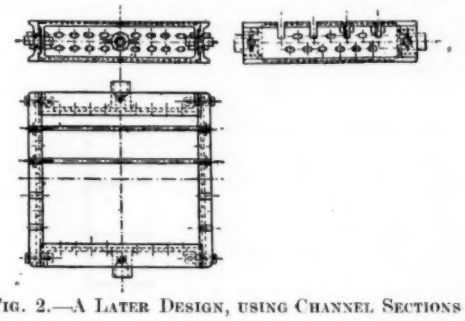


FIG. 2.—A LATER DESIGN, USING CHANNEL SECTIONS

fixed by gibs to the side pieces is shown in the illustration.

The design of the flask has subsequently been further improved. In order to simplify the connections with the cross-ties, all four sides have been made of channel section. Fig. 2 represents this latest design and Fig. 3 shows the details of the connections on a larger scale. With this

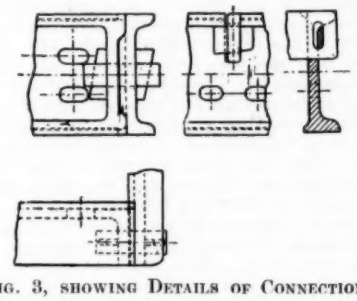


FIG. 3, SHOWING DETAILS OF CONNECTIONS.

design two or more flasks can be held together with iron cramps and the cross-ties can also be fixed to the frame in the same way.

IT IS reported that the trials on Swedish State Railways with turbine locomotives of Swedish invention have been very satisfactory. So far the consumption of fuel has been about half that of an ordinary engine.

The New Iron Foundry of Messrs. Mavor and Coulson.

The early stages of construction of the new foundry of Messrs. Mavor & Coulson, of 47, Broad Street, Mile End, Glasgow, were chequered by harassing delays in delivery of materials. Structural steel, cement, bricks, glass, everything needed, had in turn to be waited for.

The foundry building proper consists of two bays, as shown in plan view (Fig. 1), each of 2,500 sq. ft. area. Adequate provision has been made external to these two bays for storage of the sundry materials used in moulding, so that almost the whole of this area is actual working space. There are two hydraulic cranes installed in each bay, each of 2-ton lifting capacity, and a 5-ton electric travelling crane is installed in the west or cupola bay. Runways suitable for a similar crane are provided in the east bay. The hydraulic cranes have proved ideal for foundry work, as the speed of lift can be adjusted to a nicety. Hydraulic power is obtained from the Corporation supply mains, which enter at the north-east corner of the building. Two cupolas, each of 36-in. internal diameter, are installed, and a dual air supply can be applied to either or both cupolas as desired. A high-pressure fan and a blower give the alternative supplies of air, and the arrangement provides means of judging the relative merits of these machines. The light railway from the yard is brought into the foundry, and runs up the west side of the east bay, occupying space which in any case has to be maintained as a passage.

As black moulding sand reflects no light, ample provision of windows is a prime necessity in a foundry. For this reason the roof is entirely glass in steel framing, and so are the sides above a height of 15 ft. from the ground.

The cupola staging, which is roofed, is made of unusual length, to provide storage space for scrap, pig-iron and coke. This staging is 15 ft. from the ground, and has rails, corresponding to those in the yard, laid along the front. Materials contained in a tipping bogey are raised by a 2-ton hydraulic crane mounted outside the foundry wall. Immediately under this crane there is a ferro-concrete platform 7 ft. from the ground, on which the larger moulding boxes can be stored on edge; the smaller boxes, which are easily handled, are stored underneath this platform.

Various sands, blacking, and other materials required are stored in the bins in front of the yard crane. These bins are built of brick, with a ferro-concrete roof, which is also available for storage. As the plan shows, two rail routes are available for transporting materials from these bins into the foundry.

The dressing shop, which runs at right angles to the foundry, is provided with a railway, and also an overhead runway for transport of castings. Castings from the foundry pass through the dressing shop into the rough store, from which the railway is continued into the machine shop.

The core-drying stoves, five in number, open from the south side of the dressing shop. One furnace, to which forced draught can be applied, supplies the heat for this range of stoves, any of which can be blanked off by closing dampers. Pressure air from the fan can be directed under or over the grate as required, so that air can be sent through the stoves in proper quantity at suitable temperature. The gases pass through the stoves into a flue connected with the chimney. The stove doors, which are of sheet iron, with heat-insulating packing, are raised by a hydraulic ram operating on a chain, which runs through a runner carriage which can be brought over any door. It is an interesting fact that it was cheaper to provide this power lift than to use cast-iron weights to balance the weight of the doors at the present price of cast iron.

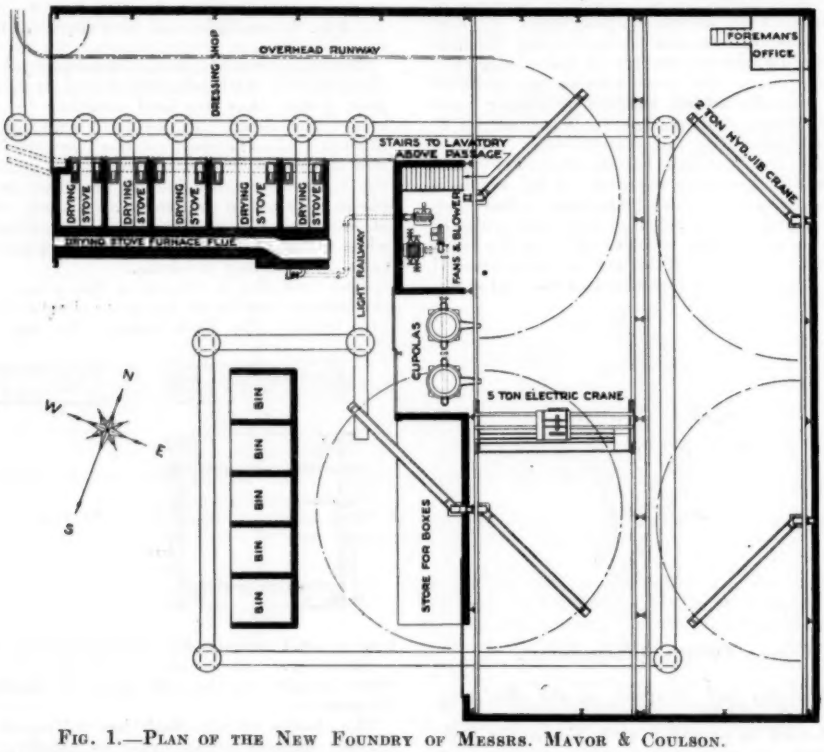


FIG. 1.—PLAN OF THE NEW FOUNDRY OF MESSRS. MAVOR & COULSON.

Lavatory accommodation is provided over the passage-way between the fan-house and the drying stoves. It is intended later to extend this over the full length of the stoves, and provide washing accommodation for the moulders and dressers.

The addition of this foundry to the works, by increasing the capacity for production of iron castings, will enable Messrs. Mavor & Coulson to escape vexatious delays to which they have been liable in the past. When fully equipped, as it is intended it shall be equipped, with labour-saving machinery suitable for the work for which it is designed, it will effect considerable reduction in costs and selling prices of its products.

AMERICAN GRAPHITE STATISTICS.—Natural graphite produced by 17 firms in the United States during 1920 totalled 9,510 short tons of 2,000 lbs. In 1919 altogether 7,422 tons were produced by 20 concerns, and in 1918 some 12,991 tons by 42 firms. Imports of graphite during 1920 aggregated 21,095 tons, against 26,626 tons in 1919 and 19,498 tons in 1918. The 1920 imports came principally from Ceylon (9.204 tons), Madagascar (4,710 tons), Mexico (3,659 tons), and Canada (2,170 tons).

Institution of British Foundrymen.

LANCASHIRE BRANCH.

A Discussion on Hard Castings.

At the meeting of the Lancashire Branch of the Institution of British Foundrymen, held on October 1 at the Manchester College of Technology, Mr. J. Pell (Rosegrove), who opened the discussion, said the problem of how to avoid hard castings had caused much trouble to foundrymen during the last few months. Having become accustomed to the use of material which gave excellent results, they suddenly found the supply of that material stopped, and it was replaced with materials about the qualities of which they knew nothing, although they might have heard that the character was not good. The foundryman had then to ask himself: What results shall I get? Must this material be used in the same proportions as the previous material? That was the type of thing which happened during the recent coal strike. The ordinary supply of foundry coke was stopped, and they had to use coke of an unknown quality, but they were expected to produce castings up to the usual standard. He would give the members an account of his own experience in the hope that their comments would afford some guidance for the future.

When the stocks of coke gave out a fresh lot was procured which, in his opinion, was very high in sulphur; it was very friable and would not carry the accustomed load. Much more had to be used than would be necessary with proper coke. On the first occasion it was used he made careful observations. The first 6 or 7 cwts. of the metal were poured into castings which did not require machining and were kept separate from the rest. The following morning, on examining them, he found that the first metal poured was quite hard. Taking the castings in the order in which they had been cast, that hardness diminished, and the last castings, although not in accordance with the former standard, could be drilled, filed, or machined. On the following days he adopted this procedure: The first 4 or 5 shanks of metal (about 7½ cwts.) were poured into castings of little importance; it did not matter whether they were hard or soft. Operations were then carried on in the usual way, and although the fluidity of the metal was not what could be desired, they were fairly successful and they were able to carry on. In charging the cupola he had to lighten the charges and use more coke in order to procure metal sufficiently hot to run the lighter castings. Usually they melted 15-cwt. charges with 1½ cwts. of coke, but with this high-sulphur coke they used 1¾ cwts. to a 12-cwt. charge. The bed was increased to help to carry the burden. He had no means of ascertaining the exact sulphur content, but it could be assumed that it was anything up to 0.1 per cent. Taking it at that figure, there should be, roughly, 1 lb. of sulphur in a bed charge of 12 cwts. His opinion was that during the melting operations the first 7 or 8 cwts. of metal, in its descent through the coke bed, absorbed a large quantity of the sulphur, and by tapping at very short intervals they clarified the coke bed somewhat. Something of this nature must have happened, because the metal that was afterwards brought down could be machined. If he had allowed much metal to collect in the cupola he would have had more hard castings. He might be mistaken in supposing that sulphur was the factor which determined the hardness of the metal, and that was the point on which he wished to hear the views of the other members, many of whom must have experienced the same difficulty. Whatever the cause was, no such trouble occurred when using local coke. He could usually take metal from the cupola two or three minutes after melting commenced and get machinable castings.

He made a visit to a foundry which had been engaged on the same class of work but had to shut down. The same poor coke was used, and the results were alarming; a number of the castings cracked in cooling. It was generally understood that light textile castings, in particular, required sand that was only sufficiently moist to bind together; if wet facing sand was used hard castings were sure to make their unwelcome appearance. In this case the trouble was not due to wet facing sand, nor to the mixing of the iron; care was taken every day to ascertain how the castings were for machining. As soon as possible each morning some of the lighter castings were tried, by mutual agreement with the foreman of the turning shop. The mixture he was using at the time the hard castings were produced was a fairly good one, the approximate analysis being:—Graphitic carbon, 2.95; combined carbon, 0.40; silicon, 2.68; sulphur, 0.060; phosphorus, 0.98; and manganese, 1.07 per cent. It was taken from a stock in use previous to the strike; in fact, nothing was changed except the coke.

The Chairman (Mr. Haigh) said he was sure that many of the members who continued working during the coal strike experienced difficulties similar to those described by Mr. Pell. Judging from the analysis the mixture should have given a machinable casting.

Mr. Hill said about 18 months ago, when furnace coke was scarce, he experimented with a soft coke showing a high sulphur content, and resulted in similar trouble to that to which Mr. Pell had made reference. The metal was hard for the first 10 cwts. In his opinion there was no real remedy so long as that coke was used; he thought the metal melted too low in the furnace and became oxidised. To the eye it appeared to be oxidised; it had a different appearance from ordinary white iron. In the middle of the blow it would become grey, but still it was harder than usual. What it was at the end of the blow they never knew, because when they had melted about 3 tons it bridged over. Under such conditions good results could not be expected. Two furnaces were used on alternate days, and a gang of men were employed in clearing out one for the following day. The castings were full of holes as well as being hard. The trouble persisted until a fresh supply of coke was obtained. If a ½ cwt. of the hard metal scrap thus obtained was added to a 10-cwt. charge when only *good* coke was used, it would turn the whole charge white.

The Chairman: What was the appearance when you tapped it out?

Mr. Hill said when the hottest metal came down it seemed initially white hot, but quickly became dull, pasty looking, and poor running. The hottest metal would come down after they had melted about a ton, after which the metal gradually became worse, and so long as tapping was possible it was associated with a skin of greasy appearance, which never cracked. The metal was usually "blown."

The Chairman: How do you account for the oxidation which you suggest had taken place? Was the blast increased?

Mr. Hill replied that they had adhered to their usual practice. There was only one row of tuyeres. The melting was slower, and since bridging was encountered he concluded that melting was at a point lower than normal.

The Chairman: You would say then that you got oxidation owing to the metal being in contact with the blast for a longer period than usual.

Mr. Hill: Yes; melting too low.

Mr. Pell remarked that in his case they were not melting too low, because he had taken the precaution of increasing the coke bed by 6 in.

Mr. Hill added that another man put coke on until he could only get one ½-cwt. charge to the charging door, but still he had the same trouble.

The Chairman: He ought not to have been troubled very much with oxidation.

Mr. Barnes said he was interested in the smallest made castings, ranging from 1 oz. to 40 lbs. at the most. During the coal strike they had bad coke, and they found that the best way to deal with it was to burn it in the furnace the day before using it. They thus eliminated much of the sulphur. When used for melting, the method was to run for a time with full blast and then reduce it to half. When making carpet-sweeper wheels, which had to be drilled from the solid boss, but before they had experimented by burning the coke the day before it was used and reducing the blast, they could not be machined even with high-speed steel.

XUM

The Chairman: Do you mean that you fired the coke in the cupola?

Mr. Barnes: Yes; the cupola was filled up not quite to the charging hole with the bad coke; it was then fired and allowed to burn to a red heat, and as the charge became red through it was withdrawn from hearth. It was just slaked and left to dry out itself, and was used the day after. The trouble was splendidly overcome in that way. No accounts of the percentage of loss were kept. At the time the coke was burned the fan was kept going. The men could not stay while the charging was going on because of the sulphur that was evolved.

The Chairman said if the whole of the trouble was due to sulphur, one would expect the coke samples to show an abnormal sulphur content—say two or three times the ordinary amount. Could anyone say what the sulphur content of the coke was?

A member remarked that he had known coke to contain 0.2 per cent. of sulphur, which was 2½ times as much as the usual proportion.

Mr. H. Sherburn said the problem was impossible to solve on account of insufficiency of evidence. Certainly several factors had been given, but as long as those stood alone the information was inadequate. They were not told the composition of the coke, the height of the bed, or whether the analysis of the pig-iron was similar to that used the day before. Until more definite chemical data was available they could only express opinions. That was one of the difficulties often experienced in the foundry. A very doubtful suggestion was the probability of oxidation being the cause of the trouble. It had not been established that oxidation was the cause of iron being turned white. The proportion of silicon would have some bearing on the problem, which emphasises the necessity of an actual analysis being available. If the sulphur content in the casting was given it would provide an avenue for exploration, but as the evidence stood, opinions, which had slender foundations, could only be expressed.

The Chairman said they had no evidence which enabled them to say definitely whether the trouble had been caused by excess of sulphur in the coke, by oxidation, by slow melting, or by some other action. Unfortunately, Mr. Pell had not been in a position to command expert advice, and they had not an analysis of the metal after melting.

Mr. H. Sherburn said in ordinary practice, using a good coke, the correct bed charge might easily be determined by noting the time taken for the first molten metal to appear from the time when the blast was started. It was, however, courting disaster to apply the same practice with a new coke without previously obtaining some knowledge of its chemical composition, particularly sulphur and ash. Further information should be sought as to its mechanical properties.

Mr. Pell remarked that metal was being brought in 11 to 12 minutes.

The Chairman remarked that if the metal was appearing in 11 minutes the melting would be satisfactory as far as the time was concerned. If melting became slow after that, something had evidently happened to the height of the coke bed; it was either falling or getting harder.

Mr. Hill said in his case the mixture was never altered. With one lot of coke good results were shown, but when this consignment was exhausted and a fresh supply obtained the trouble described arose, indicating that the mixture was not at fault. The mixture referred to was made up of equal quantities of pig-iron and scrap, a reliable brand of Scotch iron forming 30 per cent. of the whole charge.

Mr. Jowett, after being assured by Mr. Pell that the coke on breaking revealed the presence of brown specks, remarked his firm had had similar coke which contained over 0.2 per cent. of sulphur, and the chemist attributed the brown spots to sulphur.

Mr. Pell: If the trouble is a matter of oxidation, why does not a similar state of affairs exist when using good coke?

Mr. H. Sherburn suggested that the question whether the trouble was due to sulphur could be settled by analysing the raw materials used and the iron which came out. People who were managing foundries should have at their disposal all the knowledge available. If by making an analysis they could get a clearer idea what the cause of the trouble was it was far better to do that than to dismiss the subject by casually blaming the coke and, what is more important, the position would be improved for handling a similar situation should it ever again arise.

The Chairman said conditions could not be considered normal as regards good quality coke if it contained 0.1 per cent. of sulphur. In Mr. Pell's case all would agree that the trouble arose from the change in the coke, but on purely scientific grounds a definite conclusion could not be drawn, because the evidence was insufficient, and he was afraid the members could not help matters forward. The axiom of a practical man was—using the same brand of pig-iron and the same blast, the same results are obtained. Sometimes they were, and sometimes they were not, and the reason was not clear. It was here that the chemist should intervene. Until there was a system of working laboratories in connection with a number of furnaces, so long would these troubles arise, which the practical man, however good he might be, could not solve, and so long would they be in the hands of the people who sold material to them. During the coal strike his firm got some bad coke, and they got over their troubles in various ways. They found it was no use increasing the coke bed. It might be necessary to reduce the proportion of iron in the charge, but a solution could not be obtained by maintaining the standard proportions. They worked to a standard bed. They did not raise the bed more than 6 in. after the trouble began, but they reduced the charge of iron 15 per cent. for the same weight of coke. When they had finished, the same analysis, the same machineability, and the same tests were shown. If a foundryman used the standard proportion of iron with coke of that description, he would have constant trouble, and would be compelled to rearrange his mixing. For instance, he might have to increase the manganese. It was to be deplored that some foundries had to shut down owing to inferior coke. If proper information had been available those foundries could have continued working. Such information could be procured through the Cast Iron Research Association. Indeed, during the coal strike thousands of tons of castings were brought out to standard analyses, and passed through all the tests. In the case under discussion, perhaps the trouble was due to oxidation, and it was possible that it could not be cured by any of the remedies which were advertised. Evidently something had happened to the coke, but what it was could not be established until they knew the analysis of the castings.

Mr. J. Masters asked whether Mr. Sherburn had any experience of arsenic in coke.

Mr. H. Sherburn said that it was unusual to estimate arsenic in coke, but no doubt it might sometimes be present, although it is doubtful if the amount would ever be sufficient to have any material effect on the metal melted with such a coke.

The Chairman pointed out that the arsenic in an ordinary foundry coke was negligible. In the case under consideration the coke was high both in sulphur and ash, and the latter might affect the resultant mixture.

Mr. Key said the chemist would probably tell them the percentages of the ingredients which were usually found in terms of carbon, ash, volatile matter, and sulphur. Admittedly, this was helpful, but it was as far as the chemist would go. A firm were making a certain kind of casting. They made 24, which were apparently sound. The following blow, carried out under identical material, melting, and moulding conditions, another 24 castings were made, but not one of those was fit to machine. Samples of the two lots were taken to the laboratory, and the analysis did not show the slightest difference. This hopeless condition left the industry in a state of chaos.

The Chairman said that point was brought out at the Blackpool Conference. Mr. Buchanan compared the production of a pig-iron to the birth of a child, and said just as two children might be outwardly alike and yet have different qualities, so also might two castings. One could make a

casting that was quite satisfactory, and then produce another that was unsatisfactory, although chemically they might be absolutely the same.

MR. H. SHERBURN: Is Mr. Key opposing the utility of chemical analysis?

MR. KEY, replying in the negative, stated that the chemist analyses for definite ingredients, but goes no further. The analyst will not touch the question of oxidised iron, owing to insuperable difficulties. Doubtlessly, sulphur is the primary cause of the condition of the iron exhibited. The speaker could show 40 tons of iron which contains 1.24 per cent. of silicon, which has exactly the same hard appearance. The sulphur percentage is 0.4 per cent.

THE CHAIRMAN: Unless that iron has absorbed a large amount of sulphur to bring it up to that, it would not normally take place with a cupola.

MR. KEY: The rest of the analysis is normal, and characteristic of the district from where it was obtained, except the manganese is 0.3 per cent., which is lower than usual. In Mr. Pell's case no doubt sulphur has been the cause of the trouble.

MR. MILES said as the Cast Iron Research Association had been mentioned, it ought to be made plain that that body did not work for the members of the Institution unless a payment was made.

THE CHAIRMAN said the Cast Iron Research Association would take up any problem submitted to it by the subscribing members. The results of its work would not be public information, but would be the property of the members if the problem was of general interest. If it was a special problem, the work would be of a more or less confidential character.

MR. PELL said he wanted to know whether there was any way of avoiding these hard castings, and he had carefully explained the matter, but it was practically impossible for him to obtain some of the details desired, because a chemist was not employed at the works. He believed in the foundry chemist, and would be glad to have one associated with him in his work. The proceedings concluded with a vote of thanks to Mr. Pell.

Gazette.

BRITISH METAL REDUCERS, LIMITED (in voluntary liquidation). Claims to Mr. H. Morgan, 17, Eldon Street, E.C, liquidator.

DEPTFORD STEEL & IRONWORKS, LIMITED, London, S.E.—Mr. G. F. Joseph, 149, Southwark Bridge Road, S.E., was appointed receiver, October 2.

THE "AJAX" BOLT & NUT COMPANY, LIMITED, are being wound up voluntarily, with Mr. E. I. Law, Kingscourt, Bridge Street, Walsall, as liquidator.

BODILL PARKER & COMPANY, LIMITED, Birmingham, brass and iron founders. Mr. H. Harcourt, 23, Colmore Row, Birmingham, was appointed receiver, October 6.

LIEUTENANT-COLONEL J. GRIMWOOD, 2, Coleman Street, London, E.C.2, has been appointed liquidator of the Gardiner Shipbuilding & Engineering Company, Limited.

BILSTON IRON SHEET AND GALVANISING COMPANY, LIMITED.—Pursuant to section 188 of the Companies (Consolidation) Act, 1908, a meeting of creditors will be held at 19, Bedford Row, W.C., on October 28, at 3. Claims to Mr. D. F. E. Whitehouse, 121, Kingsway, W.C., liquidator, by November 19.

Deaths.

MR. EDGAR T. WARD, of the American merchant iron and steel firm of Edgar T. Ward, Sons, Company, died recently.

MR. G. NELLIST, assistant district superintendent of the North-Eastern Railway Company, died at Hull on October 16, aged 49.

MR. J. FIELDING, joint-managing director of Fielding & Platt, Limited, Atlas Ironworks, Gloucester, has died in his seventy fifth year.

M. ALBERT SARTIAUX, the famous French engineer, whose name is linked with the French section of the Channel Tunnel scheme, has died at the age of 72.

MR. J. WOOTTON, J.P., died on October 18, at Park House, Coalville, at the age of 77. The deceased gentleman was the founder and managing director of Wootton Brothers, Limited, engineers, Coalville.

MR. E. NICHOLSON, a well-known Annan engineer, has died in South Africa. The deceased established the Standard Engineering Works at Annan many years ago, and afterwards proceeded to South Africa, where he became associated with a large engineering concern.

Company News.

International Nickel Company, Limited. — Quarterly dividend, 1½ per cent. on preferred stock.

Metal Refiners, Limited.—Capital £2,000. Provisional directors: W. Gregory and J. H. Mumford.

Baldwins, Limited.—Further ordinary dividend, 2½ per cent. (free of tax), making 5 per cent. (free of tax) for year.

Pease & Partners, Limited.—Accounts for five months to September 30 show loss; interim dividend, 2 per cent., free of tax.

T. H. Dixon & Company, Limited.—Capital £12,000. Ironfounders, etc. Directors: T. H. L. Dixon, P. T Hodges (secretary) and H. W. Dixon.

A. W. Reeves, Limited.—Capital £3,000 Ironfounders, etc. Directors: A. W. Reeves, Wilhelmina Reeves, H. Markham and Beatrice H. Markham.

Stothert & Pitt, Limited.—Profit, £34,200; brought forward, £14,261; available, £48,461; further dividend, 7½ per cent., making 12½ per cent., free of tax for year

W. T. Mitchell & Company, Limited. — Capital £5,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 8, Manor Road, Stoke Newington, N.

Drake & Gorham, Limited. — Net profit, £13,433; brought forward, £12,234; dividend, 6 per cent. for year; writing down good will, £5,000; reserve, £7,400; carry forward, £5,768.

Visco Engineering Company, Limited. — Capital £1,000 in £1 shares (100 preferred and 900 ordinary). Directors: F. Truscott and G. Defries. Registered office: 21, Bedford Row, W.C.1.

Wright, Bindley & Gell, Limited.—Balance of revenue account, after including amount brought forward, £7,126; interim dividend, £2,259; final preference dividend, £2,259; carry forward, £2,607.

Hobson, James & Gilby, Limited.—Capital £6,000 Metal and alloy manufacturers, etc. Life directors: A. E. Hobson, G. T. Gilby and Helena M. Gilby. Registered office: 405, Lodge Road, Birmingham.

Foundry, Plant & Machinery, Limited. — Capital £100,000 in £1 shares. Directors: N. Cockburn, A. W. Steven, D. M. King, J. Learmouth, S. F. Corby, H. J. Kennard and Peter Dias. Secretary: J. C. Sturrock.

Fletcher, Hotton, Limited.—Capital £1,000. General engineers and engineers' agents, etc. Permanent joint managing directors: A. C. Fletcher and F. Hotton. Registered office: Thanet House, 231-2, Strand, W.C.2.

Finchley Engineering Company, Limited.— Capital £3,000 in 2,400 10 per cent. preference shares of £1 and 2,400 ordinary shares of 5s. each. Directors: J. Cowie and E. A. Endacott. Registered office: Ballards Lane, North Finchley.

H. Newton Knights & Company, Limited.—Capital £2,500. Engineers and contractors, etc. Permanent directors: H. N. Knights (chairman and managing director) and S. H. Farrell. Registered office: Astbury Works, Astbury Road, Peckham, S.E.

Kayser, Ellison & Company, Limited.— Brought forward, £10,811; credit balance, £25,186; preference dividend, £6,000; interim ordinary dividend, 2s. 6d. per share, £6,250; balance available, £12,936; final ordinary dividend, 2s. 6d. per share, £6,250, making 5 per cent. for year, less tax; carry forward, £6,686.

Personal.

THE LATE SIR GILBERT HENRY CLAUGHTON, BART., left estate of the value of £44,729, with net personalty £38,911.

THE LATE MR. F. L. CROFT, governing director of Crofts (Engineers), Limited, of Thornbury, Bradford, left £53,583.

SIR ROBERT HADFIELD, BART., has undergone a slight operation in London, and his condition is very satisfactory.

MR. F. AYTON has been elected joint managing director of Ransomes, Sims & Jefferies, Limited, in succession to Mr. V. W. Bone, who continues as a director.

THE LATE MR. R. MONROE, general manager of the Barry Graving Dock & Engineering Company, Limited, and one of the founders of the Engineers' and Shipbuilders' Employers' Association, left £26,981

MR. H. L. CRITCHLEY, at one time manager of the locomotive works of Sir W. G. Armstrong, Whitworth & Company, Limited, has been appointed general manager of the Combustion Developments Company.

MR. J. FAIRLAM, works manager to Walkers, Parker & Company, Limited, Elswick Lead Works, Newcastle, who recently completed 50 years' service with the firm, has been the recipient of presentations from the officials and men.

THE LATE MR. J. WOOD, at one time chairman of the Deptford Dry Dock, of the Tyne Dock Engineering Company, Limited, South Shields, and the Ocean Dry Dock Company, Swansea, has left estate of the gross value of £101,477, of which £96,575 is net personalty.

XUM

The Eleventh Report of the Light Alloys Research Committee.

By Walter Rosenhain, B.A., D.Sc., F.R.S., Sydney L. Archbutt, F.I.C., and D. Hanson, D.Sc., of the National Physical Laboratory, Teddington.

The 11th Report to the Alloys Research Committee, which was presented in summary to the Institution of Mechanical Engineers, on October 21, contained much that is of supreme inerest to the non-ferrous foundryman.

In presenting the Report, the Authors point out that the researches are the result of the organised work of practically the whole staff of the Metallurgical Department of the National Physical Laboratory.

Cast Alloys.

Alloys for Use at Ordinary Temperatures.—A considerable number of castings, both sand and chill, have been made and tested. Tensile strengths up to 19 tons per sq. in. in the case of sand castings and 20 tons in the case of chill castings have been obtained with alloys containing 2 to 3 per cent. Cu and about 25 to 30 per cent. Zn, whereas in alloys containing about 15 per cent. Zn tensile strengths of about 14 tons per sq. in. are recorded. For practical purposes, however, the alloys rich in zinc have certain undesirable properties; they are very weak and brittle when hot and are therefore liable to accidental injury in the foundry, and they have a relatively high density. For these reasons alloys having a rather lower zinc content, in combination with 2 to 3 per cent. copper, have been found most generally useful for castings not exposed to high temperatures. The best known is that which was widely used during the war under the Aircraft Specification "L5." This alloy contains from 12½ to 14½ per cent. of zinc, and from 2½ to 3 per cent. of copper. A freshly-cast chill test-bar is specified to show a tensile strength of not less than 11 tons per sq. in., and an elongation of 4 per cent. on 2 in., requirements which are very moderate, and have often been exceeded by the Authors. The strength of such castings, however, increases considerably on ageing.

In alloys containing up to 3 per cent. of copper the density varies from approximately 2.8 in an alloy containing 5 per cent. of zinc to 3.2 in an alloy containing 25 per cent. of zinc. Castings of "L5" have a density of approximately 3.0, the differences between sand and chill castings being inappreciable.

Cast Alloys for Use at High Temperatures.

The advantages to be gained from the use of aluminium alloys as pistons in aeroplane and other high duty internal combustion engines having been demonstrated in practical trial as well as indicated by theoretical considerations, the problem of finding the most suitable casting alloy for this purpose became of considerable importance.

In the first place, it became necessary to ascertain the strength of various alloys at high temperatures. The results of tests on aluminium-zinc alloys show that the tensile strength falls off very rapidly as the temperature increases. Further tests at high temperatures have shown that the ternary alloys of copper, zinc and aluminium behave in a similar manner. In the case of the alloy "L5," it is found that, starting with a tensile strength of about 13.5 tons per sq. in. at normal temperature, the strength falls off at 250 deg. C. to little more than 4 tons and at 350 deg. C. to about 1.5 tons. For this reason alloys containing zinc have been abandoned for use where high temperatures are involved.

The behaviour of certain binary copper-aluminium alloys in the extrusion press had suggested that they possess considerable strength at high temperatures, and an extensive series of tensile tests was therefore undertaken on alloys belonging to this system. Alloys containing 6 to 14 per cent. of copper have approximately the same strength (7 tons per sq. in.) at 250 deg. C.; at somewhat higher temperatures, however, the alloys containing 12 to 14 per cent. of copper are distinctly better than those containing lower proportions. The 12 per cent. alloy, for example, at 350 deg. C. possesses a tensile strength of about 4.6 tons per sq. in. as compared with 3.4 per sq. in. for the 8 per cent. alloy. The alloy containing 12 per cent. of copper has been extensively used for the manufacture of light alloy pistons, and is well known by its Air Board specification number "L8."

Efforts were made to improve the properties of the simple copper aluminium alloys by the addition of other elements, and it was found that manganese in small proportions has a profound influence on their strength. In alloys containing both 8 and 14 per cent. copper, both chill and sand cast, it was found that the addition of 1 per cent. of manganese causes an actual increase in tensile strength with rising temperature up to 250 deg. C.; at this point the tensile strength is approximately 1 ton per sq. in. greater than at normal temperatures. Above 250 deg. C. the strength decreases at much the same rate as that of the pure copper alloys, but, owing to the initial rise, the strength at 350 deg. C. is still very much better. In the 14 per cent. copper alloy containing 1 per cent. Mn. the strength rises from 9 tons, as chill cast, to 10 tons per sq. in., when tested at 250 deg. C., while at 350 deg. C. 6.4 tons per sq. in. are still obtained. In the case of sand castings the results at normal temperatures and at 250 deg. C. are approximately 1 ton per sq. in. less than chill castings, but at 350 deg. C. this difference has practically disappeared.

This effect of manganese was so striking that it was investigated more closely, with a view to ascertaining if the addition of greater or smaller amounts would produce better results. It was, however, found that the best results were obtained with 1 per cent. manganese, and that the effect of this element was less if the content differed appreciably from this value.

For various reasons the 14 copper, 1 manganese alloy was not regarded as the final pollution of the piston alloy problem, and other alloys were investigated. Additions of iron, molybdenum, tungsten, chromium, vanadium and other elements to copper aluminium alloys were tried without better results. In the majority of these alloys it was found that a comparatively small addition of the second element made the metal very difficult to cast. More promising results were obtained in the case of nickel-copper aluminium alloys, which were at a later date further improved by the addition of small amounts of magnesium. The first result of adding nickel is a marked increase in the tensile strength, both in the cold and at 250 deg. C. For example, the strength of the 12 per cent. copper alloy at nominal temperature is raised by nearly 2 tons by the addition of 3 per cent. nickel, and by over 3 tons per sq. in. at a temperature of 250 deg. C., at which a tensile strength of 10 tons per sq. in. is obtained. At 350 deg. C., however, the tensile strength is still rather low, namely, 5.3 tons, about 1 ton per sq. in. lower than that of the "14/1" alloy. The addition of small amounts of Mg to alloys containing both Cu and Ni led to further improvement. In one case, in an alloy containing 8 per cent. Cu, 2 per cent. Ni. and 1 per cent. Mg, a tensile strength of nearly 13 tons was observed, as compared with 8 tons in the alloy having the same Cu and Ni content without Mg. Ultimately it was found that the Cu content of these alloys could be safely reduced with considerable advantage both to lightness and to thermal conductivity, and an alloy containing 4 per cent. copper, 2 per cent. nickel, and 1½ per cent. magnesium, known as alloy "Y," was adopted. This alloy, in the form of 1 inch chill castings, possesses a tensile strength of 13 tons per sq. in at normal temperature, which only falls to a little over 11 tons at 250 deg. C., to 8 tons at 300 deg. C., and to 5 tons at 350 deg. C. An interesting and important observation in connection with this alloy is that the elongation at 350 deg. C. is fairly large (about 15 per cent.); this led the Authors to try forging and rolling of the material with very successful results.

Further experiments showed that the Ni and Mg contents of this alloy might be varied within reasonable limits without very harmful effects, but the composition originally arrived at, as quoted above, is the best of the materials tested.

Casting of the Alloys.

In addition to the ordinary precautions which have to be taken in making complicated castings, in order to avoid such defects as "drawing," evolution of gas, etc., some special points may be mentioned. In the case of alloy "Y," and other aluminium alloys containing magnesium, the method of adding this latter element is found to be of importance. In the Authors' experience it has been found best to add the magnesium in the form of pure metal cut into fairly large pieces, and to push these rapidly under the surface of the molten aluminium, so that they can dissolve without coming into contact with the air. The addition should be made immediately before the metal is poured into the mould. Some care is also necessary in making additions of nickel. Pure nickel does not readily dissolve in aluminium, and the Authors find it best to prepare a "hardener," or rich alloy, containing 20 per cent. of nickel, and to add this in the requisite quantity to molten aluminium. Hardeners richer in nickel are to be avoided on account of their high melting points.

Thermal Conductivity.

The gain in efficiency in internal combustion engines which results from the use of light alloy pistons is due not so much to any small saving in weight of the reciprocating parts as to the greater heat-conducting power of the aluminium alloy. Careful determinations of the thermal conductivities of the different alloys were therefore made. The values obtained for the various alloys do not, as a rule, differ to any large extent, although the "14/1" alloy, in the "as cast" condition, is a notable exception to this rule. In this latter case values of 0.25 to 0.27 were found in castings tested at 100 deg. C., as compared with values of 0.35 to 0.39 in the case of most of the other alloys, and with 0.50 in the case of pure aluminium. The values found for alloy "Y" are appreciably higher, 0.37 and 0.40 being obtained in the case of chill castings tested at 100 deg. C. and 300 deg. C. respectively. Annealing at 450 deg. C. has a beneficial effect on practically all the alloys, this effect being slight except in the case of the "14/1" alloy, which, after this treatment, is little inferior to any of the others. Comparison tests made on samples of cast iron gave values of 0.10 to 0.12 under similar conditions of heat treatment and testing.

TABLE I. *showing the tensile strength of Alloy "Y." 1-inch diameter Chills.*

Treatment	Ultimate Stress Tons per sq in	
	15° C	250° C
As cast	12 6	10 5
Tempered 48 hrs. at 250° C	9 8	8 6
HEAT-TREATED.		
(1) Open muffle—		
6 hrs. 480° C quenched and aged	14 9 13 4	11 3
" " tempered 48 hrs. at 250° C	13 4	10 1
48 hrs. 480° C quenched and aged	15 8	12.0
" " tempered 48 hrs. at 250° C.	13.8	9.4†
(2) Nitrate bath—		
6 hrs. 480° C. quenched and aged	14.6	12.8
" " tempered 48 hrs. at 250° C.	13.2	11.0
48 hrs. 480° C. quenched and aged	16.0*	13.7
" " tempered 48 hrs. at 250° C.	16.0	12.0
(3) Nitrate bath—		
6 hrs. 530° C. quenched in boiling water and aged	21.0‡	—

* Maximum elongation at 15° C. at 2.25 per cent. on 2 in.
† Maximum elongation at 250° C. at 3.75 per cent. on 2 in.
‡ Elongation at 15° C., 6 5 per cent.

Heat-Treatment of Castings.

Considerable improvement in the mechanical properties of cast aluminium alloys has been obtained by suitable heat-treatment. Practically all castings possess inequalities of composition due to micro-segregation during solidification. In the case of the simple copper-aluminium alloys, for example, castings containing as little as 2 per cent. of Cu normally contain free particles of the compound $CuAl_2$, whereas a saturated solid solution of this compound in aluminium contains nearly 5 per cent. of copper. By annealing at about 500 deg. C., the undissolved $CuAl_2$ can be brought into solid solution in alloys containing up to about 4½ per cent. of copper, with considerable improvement in the mechanical properties; for example, the strength of the alloy containing 2 per cent. copper was found to increase from 8 tons per sq. in. "as cast" to 10 tons after annealing, and that of the alloy containing 4½ per cent. of copper from 9½ tons to 15 tons per sq. in. At the same time a remarkable increase in elongation is produced.

Permanence of the Alloys.

In the past some doubt has at times been thrown on the reliability of aluminium alloys. Although this has now been largely dispelled by the wide use of these materials in war, the Authors decided to examine a number of these alloys from time to time, in order to ascertain what alterations, if any, took place either in the physical properties or in their dimensions. In some cases it has been possible to test materials after an interval of ten years from the time of casting. The whole of the evidence obtained shows that, within the limits of time covered by the present research, any alterations in properties are accompanied by increases in both strength and hardness; in regard to shape and dimensions, the alloys examined are all adequately stable for practical purposes.

Ageing.

The changes which are found in these alloys appear to be somewhat similar in character to the age hardening which occurs, usually in a few days, in alloys containing magnesium, after being quenched from suitable temperatures. Age-hardening is caused by gradual separation from solid solution of a dissolved substance which is more soluble at a high temperature than at normal temperature, in an alloy which has been cooled too rapidly for immediately complete separation to take place. The particles which are precipitated from solution are in a finely-dispersed condition, and cannot be seen under the highest available magnifications.

In material such as alloy "A" (3 per cent. Cu, 20 per cent. Zn) or "L5," which has been rapidly cooled, it is possible that the compound $CuAl_2$ might separate in this manner and cause the slight alterations in properties that have been found

Cast Alloys.

The alloy "L5," in the form of chill-cast bars. 1 inch in diameter, increases in strength by about 30 per cent. during the first ten months after casting, while a similar improvement in strength is also found in the harder alloy containing 3 per cent. of Cu and 15 per cent. of Zn.

Wrought Alloys.

The ageing of alloy "A," particularly in the form of hot-rolled rod and sheet, has been closely studied, and samples from the same cast have been tested at various times over a period of 5 years. The increase of strength after ageing is most marked in thin sheet, and samples which had a strength of 27 to 29 tons per sq. in. immediately after rolling, possess a tensile strength of over 32 tons per sq. in. five years later. The increase in the yield stress is still more marked, while the reduction in the ductility is small.

Circular rod and rectangular bar, 1 to 1⅝ in. thick, also became appreciably harder during the same period; the tensile strength in these cases rose from about 26 tons to about 27½ tons per sq. in., with a correspondingly small reduction in the elongation. The tests on this alloy show that ageing has by no means ceased one year after casting; it seems probable, however, that after five years it is so slow that further changes are of little practical importance. In view of the fact that these alloys are quenched and age-hardened in order to develop their characteristic properties, it does not appear likely that the increase in hardness due to prolonged ageing will be very appreciable. Some tests on "Duralumin," however, show that slight changes take place for some years after the alloy has been quenched. A sample tested in October, 1911, was found to have a yield stress of about 17 tons, a tensile strength of about 27 tons per sq. in., and an elongation of about 18 per cent. on 3 inches; another sample from the same piece of metal, tested in January, 1921, had a yield-stress of 20.5 tons, an ultimate stress of about 28 tons per sq. in. and an elongation of 15 per cent. While these changes in properties are quite appreciable, they do not suggest any serious deterioration of the alloy; in fact, from

XUM

some points of view, the aged material is better than that freshly made. On the other hand, they do indicate internal changes over a period of many years after manufacture, and it has yet to be ascertained whether these changes come to an end, or continue slowly in the same direction as that indicated by the tests, or whether, as is quite possible, the direction of change is ultimately reversed and the alloys then tend to become softer instead of harder. The changes appear to be so slow that, except for structures in which permanence over a large number of years is essential, the alloys may be regarded as stable.

Stability of Dimensions.

Difficulties have been experienced by manufacturers on account of serious changes in the dimensions of die-castings described as "aluminium castings." Although it was found that these castings consisted largely of zinc, it was thought desirable to investigate the stability of zinc-aluminium and copper-zinc-aluminium alloys in the form of complicated castings. In 1913 two similar series of complicated castings were made of a number of these alloys. The materials used included a range of aluminium alloys containing zinc and copper with and without a number of intentionally-added impurities, while at the same time similar castings were made from the purest available aluminium and from ordinary commercial aluminium. Three different dimensions of each of these casting were measured, with an accuracy of 0.0005 of an inch, as soon as possible after casting. One series of castings was then stored in a room in the Laboratory, and another was exposed to the weather, the flats, which had been machined on the castings for the purpose of making measurements, being protected by a coating of vaseline. Measurements were taken at intervals of a few months until the castings were 40 months old, and they were again measured in January, 1921, about 7½ years after they were first made. Except in one case, the largest change found in any of the castings was an increase of three-thousandths of an inch on a dimension of 11 inches; this was found in a casting of pure aluminium. The results strongly confirm the conclusion that castings of these alloys, whether pure or contaminated with the usual impurities, possess great stability of dimensions, and no serious distortion need be feared. No signs of disintegration were seen in any of the alloys. An interesting observation is that the changes in most of the alloys, but not in all, reached a maximum value about 28 months after the castings were made and that, after this period, the dimensions returned to a value in most cases very near the original.

"Season Cracking."

Some of the alloys described in the present Report have been found to be liable, in certain circumstances, to a mode of fracture very similar to that which is well-known in the case of brass as "season cracking." In this type of fracture the metal breaks by the separation of the individual crystals from one another. Such failure was first noticed in alloy "A," and it was later found that alloy "E" (Cu 2.5, Zn 20.0, Mg 0.5, Mn 0.5) and its modifications "F" (same as alloy E, but with 0.75 per cent. of Si added) and "G" (Cu 2.5, Zn 18.0, Mg 0.35, Mn 0.35, Si 0.80) could also fail in this manner. Microscopic examination showed that rapid failure of this kind is associated with a completely equiaxed microstructure accompanied by smooth, regular crystal boundaries. In the case of alloy "A" such a structure is produced by heating at 450 deg. C. When lower annealing temperatures are used failure is less rapid; for example, material that has been annealed at 300 deg. C. only fails after many hours' exposure to a relatively high stress. On the other hand, material that has been annealed at a temperature not exceeding 250 deg. C. is found to be immune from this type of failure. Reference has already been made to the fact that the maximum softness in these alloys is obtained by annealing at a low temperature. It is interesting to note that such annealing, applied to this alloy ("A"), does not produce equiaxed crystals. Although material annealed at or a little below this temperature is rendered soft and ductile, it retains an elongated microstructure. Efforts to restore "over-annealed" alloy "A" to a safe condition by thermal treatment alone were unsuccessful, but it was found possible to do this by hot working. A total reduction of not less than 50 per cent. of the cross-sectional area of the material, provided such reduction is not carried out too rapidly, is found to be sufficient for this purpose; this treatment completely destroys the original equiaxed microstructure and replaces it by a system of elongated grains, whose boundaries are very irregular. Cold working was found considerably to reduce the liability to failure by season cracking, but material which had been seriously over-annealed in the first place could not by cold-work alone be entirely prevented from failing. It must also be remembered that the physical properties of material which has been cold-rolled are not entirely satisfactory. Various modifications in composition were tried with a view to overcoming failure by season cracking. The most promising results were obtained by the addition of 0.5 per cent. of Mn to the alloy. Manganese appears to retard the crystallisation of alloy "A" and to produce a material that is immune from failure of this type unless it is drastically over-annealed. The addition of manganese, however, makes the production of the alloy by forging and rolling more difficult. It was hoped that alloy "E" and its modifications, which contain manganese, would not fail in this way. This hope was not completely realised; in order to develop the best properties in these alloys it is necessary that they be quenched and "aged," and during the process of heating, preliminary to quenching, a certain amount of recrystallisation takes place. Heating for 30 minutes at 400 deg. C. gives material with a microstructure by no means equiaxed, a result which is due to the retarding influence of Mn. A number of samples, however, after this treatment, failed by intercrystalline fracture after prolonged exposure to stress. If the quenching temperature is reduced to 375 deg. C., or still more certainly to 350 deg. C., failure in this manner is eliminated.

In the case of alloy "Y," failure by season cracking has not been observed.

Corrosion.

A number of test-pieces of zinc-aluminium and copper-zinc-aluminium alloys have been exposed to sea water for periods up to 448 days. Machined surfaces of binary zinc-aluminium alloys were found to be practically immune from corrosion in sea water, whereas those portions of the test-pieces which had not been machined were appreciably corroded. In the second place, the addition of copper to these alloys increases the corrodibility in a very marked degree, whether the surface be machined or not. On the other hand, rapid corrosion does not occur when the ternary alloys are exposed to air, and particularly when they are not exposed directly to the weather. Samples of these alloys have been used indoors for a number of years without the slightest sign of deterioration.

Alloys "A," "E," "F" and "G."

These materials cannot be exposed to sea water or even to weak saline solutions such as tap water for any considerable time without undergoing serious corrosion, ultimately leading to complete disintegration. Careful observation with the microscope has shown that corrosion of these alloys, and particularly of alloy "A," follows the crystal boundaries, but in rolled material it shows a preference for boundaries running parallel to the direction of rolling. This gives rise to a condition of lamination, or exfoliation, which is peculiar to these materials. They do not appear to be subject to atmospheric corrosion to any marked extent.

Alloy "Y."

Both in the cast and rolled condition this alloy possesses considerably better powers of resisting corrosion, even when exposed to sea water, than any other alloy described in this Report. The difference between this alloy and alloys "A" or "E" is so great that quantitative data are unnecessary. The difference between this alloy and Duralumin is not so marked, but in several instances that the Authors have observed there can be no doubt as to the better behaviour of alloy "Y." This result was unexpected on account of the high magnesium content; the low corrodibility may, however, be due to the fact that this alloy in the heat-treated condition, contains no free $CuAl_2$.

IRON AND STEEL MARKETS.

Pig-iron.

Although for the present the situation in the pig-iron industry remains as unsatisfactory as previously reported, signs are not exactly wanting that the course of future events may disclose a much more favourable outlook than is anticipated from the existing conditions in the trade. It is as yet too early to gauge the full effect of the recent sharp reductions in costs of pig-iron production, but the subsequent deflation in prices for both finished iron and steel products has doubtless been largely due to the possibility of again securing raw materials on easier terms. At the moment, however, very little pig-iron is being bought, whether of home or foreign make, the prevailing slackness of demand being also responsible for the small proportion of blast furnaces now in operation. In the Tees-side area, largely dependent upon the North-Eastern Railway Company's service for supplies of raw material, fuel, etc., it is satisfactory to learn that on November 1 new temporary freight rates for the conveyance of iron ore and limestone are to become operative. The reductions, amounting, it is stated, from about 16½ to 20 per cent., though less than had been expected, will afford some measure of relief to ironmasters, and when fuel costs also are brought down to more reasonable levels there should be ltitle difficulty in putting more furnaces in operation. In the Cleveland iron market conditions continue practically lifeless, nor is the position of the smelting industry at all improved. As previously mentioned, two more furnaces are going into blast on special iron, but the make of Cleveland and hematite pig-iron is more than ample for current requirements, and it is, indeed, rumoured that one or more furnaces on hematite may have to be laid idle if the demand does not improve. It is, of course, a costly expedient to put a furnace out of action, and this will only be resorted to under the compulsion of circumstances. It is now difficult to sell any but No. 1 and No. 3 qualities of Cleveland pig, which are respectively quoted 125s. and 120s. per ton, with a 5s. premium for export. Makers firmly refuse to take less than 119s. per ton for No. 4 foundry, but that is a price consumers are not prepared to pay. The reduction of No. 4 forge to 112s. 6d. per ton, f.o.t., or 125s. including delivery charges in Scotland, has led to only very small sales, and mottled and white are on the market for offers. The revised quotations for pig delivered Sheffield now rule: Derbyshire foundry iron, £6: forge, £5 15s.; mixed hematite, £6 15s. In South Staffordshire there is no appreciable change in the market for pig-iron. Demand is much below normal, and it is very difficult to know what prices to quote. The few people who have Northamptonshire iron to sell ask five guineas at furnaces for forge quality and 10s. extra for No. 3, and the corresponding Derbyshire figures are 110s. and 120s. But as far as can be gathered from the market, these prices are largely nominal. Good buyers would be able to cover their requirements at less; probably at 5s. less.

The weakness in the East Coast hematite market shows little sign of immediate recovery, but with the recent drastic cutting down of steel prices consequent increased demand is regarded as probable in the near future. Some fairly substantial orders are reported as booked for South Wales consumers, and there is also a revived inquiry from Sheffield. Quotations for mixed numbers are nominally at 125s. and No. 1 at 127s. 6d. A firm offer of business at a slightly lower price would probably be accepted. In West Cumberland and North Lancashire no large volume of trade is anticipated until the beginning of next year, and the general expectation is that the necessity for an important increase in production will not arise until February. Bessemer mixed numbers are quoted at £6 8s. 6d. per ton at works.

Steel.

Only very slow progress towards complete recovery of the steel manufacturing industry can, so far, be reported, and despite the general movement towards lower levels of values in all directions, buying in the various sections continues on a restricted scale. As briefly reported last week, one of the latest developments in the direction of lower prices for steel and its products was notified in the Birmingham market when angles were reduced from £13 10s. to £10, joists from £13 10s. to £10 10s., tees from £14 10s. to £11, round bars (3 in. and over) from £14 to £12, and boiler plates from £20 to £16. Manufacturers in the district state they are surrendering profits in the hope of re-establishing the market. Similar drastic price reductions in steel were also announced for the Tees-side area last week, 70s. having been knocked off the price of plates, angles, and sections, and as the makers were previously losing money, it is obvious that these latest cuts mark the limit to which the makers can go in the direction of meeting consumers' views as to price. At Sheffield, although trade continues quiet, steel makers have also determined on a price-cutting policy with a view to stimulating demand for their manufactures, the associated makers of high-speed crucible qualities having come to this decision as a consequence of the rapid fall in price of the raw materials used in production. The result is that high-speed steel containing 18 per cent. tungsten has now fallen from 3s. 9d. to 3s. 3d. per lb., and steel containing 14 per cent. tungsten has dropped from 3s. to 2s. 8d. per lb. It is hoped that these falls in price may stimulate buying considerably, for already a few firms had been doing rather better on home contracts after a long period of depression. Slackness is the rule in all kinds of tools, whether for hand or machine use. Saw and edge tool makers are doing comparatively little. For the Continent there is practically nothing doing, and very little work is coming in from the Colonies and South America. The further deflation of the exchanges has added to the difficulties of doing overseas trade

Finished Iron.

Business in the finished iron market remains quiet and uneventful with, unfortunately, many works only partially employed and almost entirely dependent upon occasional specifications for limited tonnages, buying being still restricted within the narrowest possible compass. In South Staffordshire the few mills running full time are practically confined to the production of marked bars, for which there is still a fair demand, although manufacturers would gladly welcome a much larger volume of orders on forward account to ensure continuous employment. On the other hand, makers of crown and ordinary bars are experiencing a very quiet time, approaching even acute depression. In this branch outside competition is keen, and notwithstanding recent heavy reductions in prices of these qualities, there has been, so far, no satisfactory recovery of lost markets. The substantial reduction in values of gas strip lately effected has been unavailing in reviving consumers' interest, having been to a large extent neutralised by the use of the cheaper qualities of imported steel material. In the West of Scotland malleable iron bar trade there has been little change in the general position, business continuing dull and featureless, and export trade still on the quiet side.

Ore.

In the foreign ore trade at Middlesbrough there are indications here and there of a re-awakening of interest, a few odd cargoes having changed hands during the past week or so at a price corresponding with 27s. 6d. per ton for best Bilbao rubio, ex ship, Tees. The ore being raised at seven or eight pits in Cumberland is mostly low phosphoric ore, which is quoted from 30s. to 35s. per ton at the mines.

Scrap.

Speaking generally, there is little change to be noted in the quotations for scrap metal, all sections being alike in complaining of slackness of demand, with here and there occasional improvement in sales of certain classes of metal. In the Midlands, for example, wrought iron scrap is still being sold freely at £4 5s. to £4 10s., and there is a brisk demand for balling iron, for which the makers are still offering £3 5s. Users are offering £2 10s. to £2 15s. for heavy steel scrap, f.o.r., but the majority of dealers are not too anxious to sell, being of the opinion that ere long there will be a considerable upward tendency in prices. Steel turnings, however, are being sold quite freely at 23s. 6d. to 27s. 6d., f.o.r., and the same remarks apply to cast-iron borings. Cast-iron scrap for foundries is not quite so firm, and it is difficult indeed to get more than £5 15s. for good, heavy machinery scrap broken into cupola sizes, and £4 to £4 5s. for light cast-iron. The non-ferrous market is very difficult indeed at the present moment, as there is such a great divergency in prices, especially for brass and gun-metal. This is undoubtedly influenced considerably by the large Government stocks which have been disposed off recently. Good clean copper is still firm at about £48 to £50, and scrap lead £18.

Metals.

Copper.—Opening under easier conditions, the week's markets for standard copper developed later a firmer tone, but throughout consumptive demand was quiet. American advices report a somewhat similar position on that side, although more buying is just now in

evidence on domestic account. There is very little buying at present in Continental countries, and this condition is likely to continue until an improvement is effected in the European exchange position. The market here closed on Monday with a steadier tone, December dates selling at £66 15s. to £66 17s. 6d., January £67, while 30s. was paid for "Call" three months. Refined qualities were easier, both electrolytic and wire bars receding 10s. per ton. Closing prices.—Cash: Wednesday, £66 2s. 6d. Thursday, £66 5s.; Friday, £66; Monday, £66 2s. 6d.; Tuesday, £66. Three Months: Wednesday, £67 5s.; Thursday, £67 10s.; Friday, £67 2s. 6d.; Monday, £67 2s. 6d.: Tuesday, £67.

Tin.—Closing at the week-end with a slight improvement, the opening market for tin on Monday was steady, but with buying again restricted, Eastern advices giving sales at £161 10s. to £162, c.i.f., hardly affected the position on this side, but there was, however, a partial revival of inquiry for forward dates. October was sold at £158 10s. to £158 5s., November £159 to £158 10s., December £159 10s. to £159 15s. and February £161. English ingots were steady at £157, while a premium of 10s. over standard was paid for Straits. The weekly return of tin stocks in London warehouses showed an increase of 403 tons at 4,713 tons. Liverpool stocks are 77 tons down at 1,950 tons, and the Swansea total has also decreased 14 tons to 106 tons. Closing prices.—Cash: Wednesday, £156 15s.; Thursday, £157 5s.; Friday, £158 5s.; Monday, £158; Tuesday, £156 10s. Three Months: Wednesday, £159; Thursday, £159 12s. 6d.; Friday, £160 10s.; Monday, £160 10s.; Tuesday, £158 15s.

Spelter.—After a steady upward movement in values, the week's opening market for this metal showed some slowing down of demand, with a weaker tendency in quotations. November was done at £26 7s. 6d. and January at £26 12s. 6d. Closing prices.—Wednesday, £26 2s. 6d.; Thursday, £26 7s. 6d.; Friday, £26 10s.; Monday, £26 5s.; Tuesday, £26.

Lead.—Consumption of pig lead in this country of late has fallen off to a considerable extent, both manufacturers of compounds and users for electrical purposes having much restricted buying. The demand for near metal, however, is fairly well sustained, and the Continent is now absorbing greater quantities of the metal. The supply of English lead is also reduced, due to a revival of export business, and until next month there is not much chance of relief from the threatening scarcity, hence the strength of the market. English closing prices: Wednesday, £24 15s.; Thursday, £24 15s.; Friday, £25; Monday, £25; Tuesday, £25.

Publications Received.

Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester. "The Choice of Motors for Industrial Work"

The Wellman Smith Owen Engineering Corporation, Limited, 36-38, Kingsway, London, W.C.2, have forwarded copies of their revised edition of "Open Hearth Chargers," and a handsomely illustrated brochure descriptive of the firm's new engineering works at Darlaston, recently erected on the most modern lines, embodying every improvement ensuring the highest efficiency in the production of their numerous specialties.

MISCELLANEOUS advts., see also page 20.

ORDERS WANTED for small Machine-made Castings in Brass, Gunmetal, Phosphor, or Manganese Bronze. Also Castings any size up to one ton in weight. Prompt delivery.—James G. Crowther, Paradise Street Brass Foundry, Sheffield.

PATTERNS and CASTINGS SUPPLIED WHICH GIVE SATISFACTION. Inquiries solicited. Quotations by return of post or telephone. You can secure good-class work, reasonable prices, and promptitude in delivery by placing your orders with Videx Pattern Works and Foundry, Huntsworth Mews, Upper Baker Street, London, N.W.1. (Telephone, Paddington 364).

ORDERS wanted for Wood Moulders, Snap Boxes, Stump and Machine, Oddside Frames, Trays, ½-side Frames, Press and Stump Boards Rim Patterns, etc.; quick delivery.—Send your requirements to John J. Buck, Foundry Requisite Manufacturer, 30, Temple Road, Willenhall, Staffs.

ENQUIRIES SOLICITED FOR CASTINGS IN IRON, machined or unmachined, up to fifteen cwt. Complete machines built throughout to specification, singly or in quantity. Jig and Tool Work a speciality.—C. S. Peatfield, Limited, Market Rasen.

FOR SALE, cheap, 100 tons of Foundry Pig-iron, planished, and C.R. C.A. Sheets, Joists, Channels, Angles, Tees, Plates, all thicknesses, Plumbago.—Ascon, 10, Goldsmith Place, Kilburn, N.W.6. Telephone: Hampstead 8532.

LIGHT FORGINGS UP TO ABOUT 4½ INS. ROUND, UNITS OR REPETITION WORK; GATES AND RAILINGS, ETC. Designs and estimates submitted and samples for approval. SWEET & COMPANY, LIMITED, Engineers, Fishponds, Bristol.

CASTINGS MADE RUSTLESS

Write for Particulars.

The Rustless Iron Co., Ltd., Trico Works, KEIGHLEY.

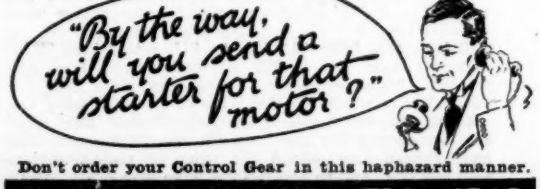
Jno. STEVENSON Ltd.
(*Formerly Jno. STEVENSON*).
Head Office: MIDDLESBROUGH.
PIG IRON. COALS. COKE.
HOME AND EXPORT.

Grain Chill and Steel ROLLS, HEAVY CASTINGS,
IRON up to 100 Tons. STEEL up to 40 Tons.
Special Air Furnace. *Siemens' Steel Only.*
R. B. TENNENT, Limited, COATBRIDGE, N.B.

SHEET METAL & GALVANIZING CO., LTD.,
SPENCER ROAD, LIDGET GREEN, BRADFORD.

Improved Sliding Bar for Foundry Flasks.
Patent applied for.

MAKERS OF
'CORRUGATED' PRESSED STEEL FOUNDRY FLASKS
TO ANY SPECIFICATION.
See DETAILED ADVERTISEMENT Next Week.



Don't order your Control Gear in this haphazard manner.
ELLISON ELECTRIC CONTROL GEAR